Printed on Thin Paper for Foreign Circulation.

NOV 24 1922

The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIV.—No. 3489] LONDON: FRIDAY EVENING, NOVEMBER 10, 1922 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
1. SHEETS, MILD STEEL, PLAIN.
2. PLATES, MILD STEEL, PLAIN.
Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 1st December, 1922.
T. RYAN,
700 Director-General.

Assistant Engineers Re- QUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of 12 to 18 months, with possible extension. Salary £480 per annum, rising by annual increments of £30 to £720 per annum, and thence by annual increments of £40 to £920 per annum. Outfit allowance of £60 on first appointment. Free first-class passages and single quarters provided. Liberal leave in England on full salary after each tour. Candidates, age between 25-35 preferably unmarried, must have had a good general education and (a) be A.M.I.C.E. or hold equivalent professional qualifications, or (b) have passed the full examination of the Institution of Municipal and County Engineers. They must have had proper technical training and have had not less than three years' subsequent experience on large engineering or municipal works preferably including experience in waterworks construction and maintenance.—Apply at once, in writing, stating age and detailed qualifications and whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W., quoting M/11,603. 711

Candidates Required for following ELECTRICAL and MECHANICAL POSTS in Mesopotamia :—
WATER SUPPLY SUPERINTENDENTS.
MILLWRIGHT ENGINEERS.
MAINS' SUPERINTENDENTS.
METER EXAMINER.
POWER STATION ENGINEER.
Rates of pay between £450 and £550. Term of service 2 years, passage paid. Age not over 35 years. Strict medical examination to be passed. Ex-Service qualifications essential. Wives and families not allowed to proceed.—Apply within 7 days, by letter only, to AIR MINISTRY (D.W.B.8.), Adastral House, Kingsway, enclosing particulars (copies only of testimonials) and stating whether married. 724

Wanted, Examiners for service in the Aeronautical Inspection Department. Only candidates having ex-Service qualifications will be considered. All applicants must pass the Ground Engineer's Examination in Category B or D; must have previous experience in the examination of aircraft metallic and non-metallic materials, detail parts, manufacturing processes and assemblies; such technical training to ensure a sound elementary knowledge of mathematics, machine drawing and applied mechanics, including the strength of materials; and previous workshop experience in engineering or allied trades. Salary £330 p.a. Successful candidates will be required to serve in any locality within the British Isles.
Apply, SECRETARY, Air Ministry (D.A.I.), Adastral House, Kingsway, W.C. 2, stating experience, ex-Service qualifications, &c. 705

Administrative County of LONDON.
The London County Council invites TENDERS for the SUPPLY of TWO WATER-TUBE BOILERS with MECHANICAL STOKERS and ACCESSORIES for the Northern Outfall Works, by Beckton Gasworks, East Ham, London, E. 6. Each boiler is to have a normal evaporative capacity of 15,000 lb. of water an hour.
Persons desiring to Tender may obtain on and after Monday, 13th November, 1922, the drawings, specification, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £2. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected at the Old County Hall before the payment of the fee.
No Tender received at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 4th December, 1922, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
715 Clerk of the London County Council.

Great North of Scotland Rail- WAY COMPANY.
CONTRACTS FOR STORES.
The Directors of the Great North of Scotland Railway Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES, for three, six, or twelve months, in the Company's option, from 1st January, 1923 :—

	No. of Form.		No. of Form.
Brooms, Brushes, &c.	1	Glass (Plate and Sheet), Lamp Chimneys, &c.	14
Canvas, Ropes, Flax, and Twine	2	Handles (Hammer, &c.) and Shunting Poles	15
Carriage Cloth and Trimmings	3	India Rubber Goods, Balata Belting and Engine Packing	16
Carriage Furnishings (Locks, Hinges, &c.)	4	Iron Castings	18
Cement and Lime	5	Ironmongery	19
Chamois Skins and Sponges	6	Leather	22
Cotton Waste, Lamp Wick, Sponge Cloths, Flannel, &c.	7	Nails, Tacks, Taper Pins, Screws and Cotter Pins	24
Crucibles	8	Soap and Candles	27
Draughtsmen	9	Sawers' (Wood) and Washers	28
Files, Steel, and Steel Castings	11	Springs (Bearing, Buffing, &c.)	29
Fire clay, Bricks, Pipes, &c.	12	Transfers (Carriage, &c.)	32
Galvanised Fencing and Signal Wire	13	Telegraph Material	32A

Forms of Tenders can be obtained from the Stores Superintendent, 80, Guild-street Aberdeen, on payment of One Shilling for each form.
Patterns may be inspected at the Stores Depot, Inveraric, between the hours of 10 a.m. and 4 p.m., from Monday, 20th November, to Monday, 4th December, inclusive, except on Saturdays, 25th November and 2nd December, when they will not be on view after Twelve o'clock Noon.
Tenders, endorsed "Tender for Stores," must be lodged with the undersigned not later than 10 a.m. on Thursday, 7th December next.
The Directors do not bind themselves to accept the lowest or any Tender.
T. S. MACKINTOSH,
Secretary.
Company's Offices,
80, Guild-street, Aberdeen,
8th November, 1922. 703

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Renovating Westminster Hall Roof.

International Telephony.

Institution of Civil Engineers: Presidential Address.

Large Tank Locomotive: Glasgow and South-Western Railway (With a Two-Page Drawing).

The Motor Car Shows—No. II.

Developments in Radio-Telegraphy.

Irish Railways.

Rainfall, Main Drainage and Roads.

PUBLIC NOTICES

Bengal-Nagpur Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for :
HEXAGON TURRET LATHES.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 8th November, 1922.
A fee of £1 1s. will be charged for the specification, which will not be returned.
Tenders must be submitted not later than Noon on Friday, 17th November, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
T. R. WYNNE,
697 Managing Director.

State Electricity Commission OF VICTORIA.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 23/3.—HIGH-PRESSURE STEAM, DRAIN AND FEED PIPING, VALVES, TRAPS, &c.
CHARGE.—£2 2s. for the first two copies complete with Tender forms, conditions of contract, specification and drawings. This charge is returnable on receipt of a bona fide Tender. A third or any further copies will be supplied for the sum of £1 1s. each, but this charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £50 is to be lodged with the Tender.
The specification may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 24th January, 1923.
R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 660

State Electricity Commission OF VICTORIA.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to—
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 23/2.—SWITCHGEAR AND ACCESSORIES.
CHARGE.—£2 2s. per set of three copies complete with Tender forms, conditions of contract, specification and drawings. This charge is returnable on receipt of a bona fide Tender. A fourth or any further copies will be supplied for the sum of 10s. 6d. each, but this charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is to be lodged with the Tender.
The specification may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on the 15th January, 1923.
R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 660

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. LOCOS. and TENDERS. Due Noon, 6th December.
2. STEAM PIPING, &c.
3. PLATE and SHEET GLASS, &c. } Due Noon, 22nd November.
4. RAILWAY TICKETS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each for Nos. 1 and 2 and 10s. each for Nos. 3 and 4 (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG,
Secretary.
Offices, 91, Petty France,
Westminster, S.W. 1.
6.11.'22. 707

City of Leicester Waterworks. EVINGTON SERVICE RESERVOIR.
The Water Committee are prepared to receive DESIGNS and TENDERS for the CONSTRUCTION of a COVERED SERVICE RESERVOIR of 5,000,000 gallons capacity at Evington, near Leicester.
General information and conditions to be observed in submitting designs and Tenders, together with key and contoured plans of site can be obtained on application to the undersigned.
Designs and Tenders, addressed to the Chairman of the Water Committee, Waterworks Office, Bowling Green-street, Leicester, must be received not later than 10 a.m. on December 7th, 1922, endorsed "Tender for Evington Reservoir."
The Water Committee do not bind themselves to accept the lowest or any Tender, nor to reimburse contractors for any expense they may incur in preparing Designs and Tenders.
G. T. EDWARDS, M. Inst. C.E.,
Water Engineer.
Waterworks Office,
Bowling Green-street, Leicester 696

The Great Indian Peninsula RAILWAY COMPANY.
The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		Fee for Specification.
1.	BRASS SHEETS, COPPER TUBES, &c.	£1
2.	LEATHER BELTING, &c.	7s. 6d.
3.	ANVILS	5s.
4.	RIB COCKS, &c.	5s.
5.	WOOD HANDLES	2s. 6d.
6.	RAMPS	2s. 6d.
7.	WICKS, &c.	2s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Brass Sheets, &c.," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 21st November, 1922.
The Directors do not bind themselves to accept the lowest or any Tender.
R. H. WALPOLE,
Secretary.
Company's Offices,
40, Copthall-avenue, E.C. 2,
London, 8th November, 1922. 721

SITUATIONS OPEN

THE POSITION of DRAUGHTSMAN Advertised in the issue of this paper dated October 6th, HAS NOW BEEN SETTLED. Will all applicants kindly note, and accept our thanks for their trouble?—JOHN BUTLER and CO., Ltd., Stanningley Ironworks, near Leeds. 709 A

SITUATIONS OPEN (continued)

WANTED, FIRST-CLASS STEEL FOUNDRY MANAGER, one who possesses initiative and can turn out sound Castings up to 12-15 tons on economical lines. Must be capable of reorganising existing foundry and, if necessary, design and equip new one. Give full particulars of career, qualifications, and salary expected.—Address, 693, The Engineer Office. 693 A

WANTED, GENERAL MANAGER, by Firm of Electrical and General Engineers, makers of dynamos and motors, employing about 300 hands. State age, salary expected, and past experience, which it is essential shall have been of a similar nature. Replies in confidence.—Address, 728, The Engineer Office. 728 A

WANTED, WORKING SUPERINTENDENT for Steam Station, West Indies; competent to Take Charge of Station and do Running Repairs; age 30-40, unmarried, with experience of Bellis Engines. Give references and experience.—Address, P6395, The Engineer Office. P6395 A

WANTED, WORKING TRACK SUPERINTENDENT, with knowledge of Electric Welding, for Tramways System in West Indies; age 30-40, unmarried. Give references and experience.—Address, P6396, The Engineer Office. P6396 A

ENGINEER, SENIOR ASSISTANT, with Good theoretical training and wide general Engineering experience, REQUIRED for London Office of an important firm; accustomed to Control of Staff in the Preparation and Development of Engineering Schemes of all kinds. Excellent opportunities for a man of initiative and resource. Good salary, according to qualifications.
Address, P6420, The Engineer Office. P6420 A

FIRST-CLASS REINFORCED CONCRETE DESIGNER REQUIRED, preferably with some experience of Grain Silo Work.—Reply, G.P.O. 538 Manchester. 704 A

REQUIRED, ONE or TWO YOUNG MEN, with practical and technical training for Estimating Department and Outside Representation, Refrigerating Machinery.—Address, giving usual particulars and salary required, P6419, The Engineer Office. P6419 A

WANTED, Competent DRAUGHTSMAN, by Firm of Laundry Engineers; experience in Designing Laundry Machinery essential; no others need apply. State age, experience and salary required.—Address, 725, The Engineer Office. 725 A

WANTED, Experienced RAILWAY CARRIAGE and WAGON DRAUGHTSMEN.—Apply by letter, stating experience and salary required, to BIRMINGHAM RAILWAY CARRIAGE and WAGON CO., Ltd., Smethwick. 710 A

COMPETENT DRAUGHTSMAN WANTED IMMEDIATELY for Iron and Steel Works Plant.—Address, stating age, exp. and sal. reqd. 718, The Engineer Office. 718 A

DRAUGHTSMAN (First-class) WANTED, Experienced in Mechanical Design and Development of A.C. and D.C. Machines. Permanent position for the right man.—MATHER and PLATT, Ltd., Park Works, Manchester. 695 A

DRAUGHTSMAN for General Structural Steel Work; capable of calculating, designing and estimating. Progressive berth for suitable man. Send full particulars of age, experience, and salary desired.—Address, P6434, The Engineer Office. P6434 A

DRAUGHTSMAN REQUIRED in London. Must be thoroughly experienced in Air Compressor Details. State age, experience and salary required.—Address, P6423, The Engineer Office. P6423 A

DRAUGHTSMAN REQUIRED. Experienced in Heating, Ventilating and Dust-Removal Plants. State age, experience and salary to Box 98, c/o Mather and Crowther, Ltd., 16, New Bridge-street, E.C. 4. 699 A

DRAUGHTSMAN REQUIRED for Engineers' London Office; thoroughly experienced in Designing and Laying-out Mechanical Handling Plants for Coal, Ore, &c. Only men with first-class experience as above need apply. State experience, age and salary required, and when at liberty.—Address, 714, The Engineer Office. 714 A

DRAUGHTSMAN WANTED, Experienced in Designs of Steel Works Plant, including Melting and Heating Furnaces and Rolling Mills. State age, experience, technical training and salary required.—Apply by letter only, Chief Draughtsman, Messrs. STEWARTS and LLOYDS, Ltd., Clydesdale Iron and Steel Works, Mossend, near Glasgow. 717 A

DRAUGHTSMAN WANTED, Thoroughly Skilled man used to Lift Work.—Apply by letter only, stating age, experience and salary required, EXPRESS LIFT CO., Ltd., 9, Greycoat-st., Westminster, S.W. 1. P6401 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
PATENTS, Page 2.
MACHINERY, &c., WANTED, Page 2.
FOR SALE, Pages 2 and 3.
AUCTIONS, Pages 3 and 96.
PREMISES TO LET OR WANTED Page 3.
WORK WANTED, Page 3.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 499, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 95.

SITUATIONS OPEN

DRAUGHTSMEN (Age 28/40 years) REQUIRED for manufacturing side of General Engineering Work; must be thoroughly conversant with Static and Rotary Sub-station Lay-outs, Cable Arrangements and Details. Experience of Power Station Lay-out an advantage. State full particulars and salary required. —Address, 694, The Engineer Office. 694 A

FIRST-CLASS DRAUGHTSMEN REQUIRED for Aeronautical Work; applicants must have had wide general, and preferably some Aircraft Experience —Apply, BRISTOL AEROPLANE CO., Ltd., Filton, Bristol. P6359 A

LADY TRACER REQUIRED by Engineering Firm, S.E. district; must be neat and accurate.—Address, stating age, experience and salary required. P6399, The Engineer Office. P6399 A

SITUATIONS WANTED

A.M.I.C.E., 14 Yrs.' Experience on Large Works, DESIRES responsible POST as Contractors' Agent or Resident Engineer, &c. Good experience of steel erection, also foundations, railway and building work on a large scale.—Address, P6432, The Engineer Office. P6432 B

AS WORKS MANAGER, Thoroughly Practical, Well-educated Engineer, sound shop and D.O. experience, loco., steam, general engineering, millwrighting, ironfoundry and repair work. Past 23 years successful control of labour as foreman and works manager.— Address, P6277, The Engineer Office. P6277 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionality wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.— Write, Z. M. 615, c/o Deacon's, Leadenhall-street, E.C. 695 B

CAPABLE WORKS ENGINEER, Age 34, with technical and practical experience of steam, gas, electrical, maintenance; experienced buyer also; London area preferred.—Address, P6397, The Engineer Office. P6397 B

COPPER ROLLING AND WIRE DRAWING.— Qualified ENGINEER, with up-to-date experience, REQUIRES RESPONSIBLE POSITION; could supervise erection of plant and take charge of department.—Address, P6423, The Engineer Office. P6423 B

ENGINEER AT LIBERTY. General Mechanical experience; has held responsible positions as chief and works engineer; late chief engineer, Isleworth Rubber Co., Middlesex; extra 1st Class Engineer, B.O.T.; age 35.—Address, P6405, The Engineer Office. P6405 B

ENGINEER, A.M.I.C., M.I.M.E., with 25 Years' experience in mining, docks, railway and contractors' plant and machinery, is OPEN to REPRESENT a few FIRMS in South Wales.—Address, 689, The Engineer Office. 689 B

ENGINEER, CONSTRUCTIONAL (24), Recently in charge of contract in West Indies, now completed, SEEKS RESPONSIBLE POSITION, preferably abroad; experienced in both theoretical and practical sides of reinforced concrete design and construction; can organise and control labour, native or otherwise; excellent refs.—Address, P6410, The Engineer Office. P6410 B

ENGINEER, Late Manager of Small London Works, with good general engineering experience, SEEKS responsible POST in works or office. Good references. —Address, P6428, The Engineer Office. P6428 B

ENGINEER, Structural and General (35), 17 Years' experience, shops, D.O., commercial, and past 3 years WORKS MANAGER to large European firm in India, is DESIROUS of CHANGE; energetic, excellent organiser, thoroughly experienced design, estimating and general engineering sales; open to offer AT HOME OR ABROAD.—Address, P6356, The Engineer Office. P6356 B

ENGINEER TO TAKE CHARGE of HEAVY OIL or GAS ENGINES. Address, P6404, The Engineer Office. P6404 B

MANAGER (40) DESIRES RESPONSIBLE POSITION, home or abroad; practical and commercial experience; moderate salary.—Address, P6424, The Engineer Office. P6424 B

MECH. and ELEC. ENGINEER (28), Single, A.M.I. Mech. E., A.M.I.E.E., expert on Diesel and all classes of Int. com. engines, experienced engineer in steam and elec. plant, D.O., structural and loading plant, railway, loose., rolling stock, workshop and all mining plant, last post 9 years chief engineer of large mining co. abroad, SEEKS ENGAGEMENT, home or abroad. Energetic and sound constitution.— Address, P6426, The Engineer Office. P6426 B

QUALIFIED MECHANICAL ENGINEER (35), educated Public School and Technical College, trained shops and drawing-office, DESIRES CHANGE; extensive experience at home and abroad; commercial experience in steel and machinery trades. Capable technical linguist.—Address, P6417, The Engineer Office. P6417 B

RESPONSIBLE APPOINTMENT WANTED by Advertiser: Extra 1st Class B.O.T. Cert., Assoc. Hull Tech. College; wide experience; highest references. WALKER, 2, Carlton-terrace, Swansea. P6349 B

SERVICES in EXCHANGE for EXPERIENCE.— Young man (23) MUST gain experience; 3 years' apprenticeship, Cambridge Hons. Eng. Degree, D.O. exp., good draughtsman. No initial salary asked.— Address, P6384, The Engineer Office. P6384 B

YOUNG MAN (19), Keen, Energetic, Matriculated and studying for degree, DESIRES POST in London as Tracer or Junior Draughtsman.—S., 60, Verdant-lane, Catford, S.E. 6. P6421 B

YOUNG ENGINEER (22), G.I. Mech. E., College trained, DESIRES APPOINTMENT, preferably where works experience can be gained; D.O. and some works experience.—Address, P6411, The Engineer Office. P6411 B

DRAUGHTSMAN, Mechanical and General Engineering, REQUIRES SITUATION.—S. O. HIGGOTT, Branstone, Burton-on-Trent. P6416 B

DRAUGHTSMAN, 2 Yrs. Shop, 2 Yrs. D.O., Mechanical and instrument design, studying for A.M.I.E., and City and Guilds, moderate salary, good refs., DESIRES POST at once.—F. D., 143, Sandringham-road, Dalston, E. 8. P6407 B

DRAUGHTSMAN (Advanced Junior), 6½ Years' shops and D.O. experience, lay-outs, machine details, &c. Quick and accurate tracer. Moderate salary. Address, P6430, The Engineer Office. P6430 B

JIG and TOOL DRAUGHTSMAN (late Senior charge) used to internal combustion engine and light car work, planning and plant lay-out, good technical man, 4½ years' shop experience, SEEKS SITUATION; pers. or tun.; age 24.—Address, P6424, The Engineer Office. P6424 B

JUNIOR DRAUGHTSMAN SEEKS POST; 5 Yrs. shop, 2½ yrs', D.O. experience, aircraft and gen. engineering; good tech. training; age 23.—G. W. JENKINS, Rectory-road, Farnborough, Hants. P6427 B

FITTER and TURNER (25), Exp. in Factory Maintenance and production work; good worker and reliable, ex. 749.—DUDOK, 144, Hamlet-road, Twickenham. P6429 B

SITUATIONS WANTED (continued)

TURNER WANTS SITUATION, Age 32. Full particulars, Apply, J. F. WRIGHT, 45, Littledale-street, Kempston-road, Bedford. P6355 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co., 46, Watling Street, London, E.C. 4.

Established seventy years.

ACTIVE DIRECTORSHIP VACANT, Engineering Firm; investment £5000, full-time occupation; remuneration £1200 p.a. Open to solicitor's and accountant's investigation. Write, Box 465, c/o Mitchell's Advertising Agency, 1, Snow-hill, E.C. 1. 730 C

EDUCATIONAL

A BROCHURE on "ENGINEERING SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of TRAINING, will be sent post free on application to SECRETARY, THE INSTITUTE OF ENGINEERING SALESMANSHIP, 333, Oxford-road, Manchester. P6195

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.E.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—3/11, Trafford Chambers, 58 South John-street, LIVERPOOL. Ex. B

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. O. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780. Ex. B

LEARN SURVEYING AND LEVELLING.— Thorough practical instruction given by an expert. —Address, E. MOUL (late L.S.W. and S.P.D. Rlys.) Hollybank, Woking. P6221 B

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, £3 3s. Write for particulars.—PENNINGTONS, University Tutors, 354 Oxford-road, Manchester. Estab. 1876. Ex.

CORRESPONDENCE COURSES in REINFORCED CONCRETE DESIGN by Mr. GOWER PIMM, Assoc. M.Inst.C.E., M.C.I., M.Inst.Struct.E., 72, Queen Square, Bristol. 721 B

AGENCIES

AN ENGINEER, M.I. Mech. E., Resident in the Midlands and representing a well-known firm, WISHES to ACT also for another HOUSE, whose goods are of interest to Borough Engineers and the Managers of Water and Gas Works, &c. Travelling exs. and comm. only for saleable high-class article.— Address, P6351, The Engineer Office. P6351 D

ENGINEER, Energetic, and with Good Social Connections, will shortly be OPEN to REPRESENT ONE or TWO high-class FIRMS in Manchester district. Ground floor office in unique position.—Address, 712, The Engineer Office. 712 D

EXPERIENCED ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES to ACT as PURCHASING AGENT in London for Municipality, Railway Co., or good firm, ABROAD.—Address, P6156, The Engineer Office. P6156 D

SOLE AGENCIES OFFERED to STOCKISTS for extraordinary new proved Engineers' Tool by manufacturer. Exceptional opportunity. Principals only. Bank references.—Address, P6413, The Engineer Office. P6413 D

STRUCTURAL STEEL WORK, CASTINGS, MACHINERY, &c.—ENGINEER, with office in Westminster, is OPEN to REPRESENT, in London, first-class Manufacturers of above. Commission basis. —A. J. CRIPPS, Windsor House, Victoria-st., S.W. 1. P6418 D

MISCELLANEOUS

DESIGN WANTED by Firm of Engine Builders for Atomising and Injecting Gear suitable for vertical two-stroke cycle crude oil engine. Replies, stating terms, invited only from those having actual experience in the working of such engines.—Address, P6412, The Engineer Office. P6412 I

FOR DEVELOPMENT of LAND Suitable for Factories, &c., with facilities for transport by river, road, and rail, near important town. An energetic and practical PERSON, with experience, is REQUIRED to Take Charge of present Small Power Plant, Transport, and Supervision of Men, and future Building, Road, and Sewer Works. Investment can be arranged if desired. Only fully interested and capable person devoted to his work need apply under address, J. BRALEY, 263, St. John-street, E.C. P6433 I

LEARN to WRITE ARTICLES and STORIES; earn while learning. Booklet free. REGENT INSTITUTE (Dept. 213), 13, Victoria-street, S.W. 1. P6431 I

LONDON LTD. CO., Capital £18,700, Trade £48,000, own freehold works £17,975, REQUIRE THREE GENTLEMEN, OPEN NEW BRANCH SHOWROOMS, Co. paying expenses. Investment £850 to ord. shares. Salary £312, good com. dividend. Audited balance sheet. Refs. req. Manft. power units, sprockets, motor cycles, electric signs, &c.— Messrs. TITCHFIELD, 29, Gt. Titchfield-street, Oxford-street, London. P6409 I

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 3in. to 24in. dia.—E. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No. 670 Hop. 533 H

FOR SALE or HIRE, ELECTRIC MOTORS from 60 to 300 H.P.; PORTABLE STEAM ENGINES from 3 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description in reasonable terms, immediate delivery.—J. T. WILLIAMS and SONS, 97, Queen Victoria-street, London, E.C. 'Tel. City 3214. Ex. B

PATENTS

INVENTIONS DEVELOPED, PATENTED, and SOLD for Clients by Engineers (late of Vickers Ltd., B.Sc., M.E. Ap. S., A.M.I. Ae. E.). Strictest confidence, most moderate terms.—FORTIS and PARTNERS, 60, Queen Victoria-street, E.C. 4. Tel., Cent. 3864. 512 H

THE OWNER of PATENT No. 25,212 of 1912, for "Improvements in or relating to the Rolling of Metal Bars and the like," DESIRES to LICENSE or SELL the PATENT RIGHTS in Great Britain.— Address, E. P. ALEXANDER and SON, Chartered Patent Agents, 306, High Holborn, London, W.C. 1. 730 H

THE PROPRIETOR of BRITISH PATENT No. 121,956, dated 4th October, 1917, for "Improvements in Electric Welding," is DESIROUS of ENTERING into NEGOTIATIONS for the EXPLOITATION of the invention in Great Britain.—For particulars apply, MEWBURN ELLIS and CO., 70/72, Chancery-lane, London, W.C. 2. P6398 H

MACHINERY, &c., WANTED

WANTED, a NUMBER of SECOND-HAND ELECTRIC MOTORS, approx. 50 H.P., 440 volts D.C. Also suitable STARTERS. State particulars, speed, &c.—Address, P6367, The Engineer Office. P6367 F

WANTED IMMEDIATELY, 12in. LOCO., 6ft. wheels coupled; 12-Ton Crane Type NAVVY; 5 and 10-Ton CRANES. Full details, lowest price and place of inspection.—Address, 701, The Engineer Office. 701 F

WANTED, 8ft. 6in. Diameter COCHRAN BOILER, not less than 100 lb. working pressure.— Address full particulars and price, P6415, The Engineer Office. P6415 F

WANTED, OVERHEAD ELECTRIC CRANES, three-motor type, ONE 5-Ton, 39ft. 8½in. span, to work in 5ft. 6in. overhead clearance and 9in. end clearance, with 20ft. lift. Current 440 volts, 3-phase, 25 cycles. ONE 7 to 10-Ton, 47ft. span, to work in 8ft. 6in. overhead clearance and 10in. end clearance, with 18ft. lift. Current 440 volts, 3-phase, 50 cycles. Must be in good condition. State lowest price and where can be inspected. Address, 722, The Engineer Office. 722 F

WANTED, New or Second-hand MAGNETIC SEPARATOR for Brass Turnings.—Apply, HARPER, PHILLIPS, Eastgate, Grimsby. 723 F

ONE 10-Ton STEAM SCOTCH DERRICK CRANE with 75ft. jib.—Send price and full particulars to BRAITHWAITE and CO., Engineers, Ltd., West Bromwich. 713 F

FOR SALE

A LEADING LIST

OF NEW and SECOND-HAND MACHINERY can be obtained from W. H. PEASE and CO., Ltd. Hastings House, Norfolk-street, London. TELEGRAMS: "ENGIPEASE, ESTRAND, LONDON." SEE OUR ADVERT. ON PAGE 35 OF THIS ISSUE. Ex. G

DIESEL MOTOR, Vertical Type, Single Cylinder, by Benz, Mannheim, 70-84 H.P., with 190 revs. For tar and gas oil suitable for lighting or factory use, little used, practically new, perfect condition (with efficiency certificate). FOR SALE, owing to alterations in factory. At present in Germany, where can be seen working. Further particulars, address, P6400, The Engineer Office. P6400 G

DISMANTLING OF BOROUGH OF HAMPSTEAD ELECTRIC GENERATING PLANT.

BUYERS have now an OPPORTUNITY to PURCHASE CHEAPLY:—

BELLISS ENGINES, DYNAMOS, TURBINES, EXCITERS, MARINE and ECONOMIC TYPE BOILERS, CONDENSERS, COOLING TOWERS, WATER SOFTENERS, PUMPS, TANKS, PIPING, &c.

For further particulars apply, THOS. W. WARD, Limited, SILVERTOWN, LONDON, E. 16. Ex.

FOR IMMEDIATE SALE to Avoid bringing into stock:—THREE 64-Ton STEAM LOCOMOTIVE TRAVELLING CRANES, by Booth, to run on an overhead gantry, 37ft. span, lifts 24ft. and 72ft. long, weight about 40 tons each. Very low price will be accepted.—GEO. COHEN SONS and CO., 600, Commercial-road, E. 14, London. 695 G

FOR SALE, PUMPING PLANT, Including Crossley 8 Type Suction Gas (convertible to town gas) Engine, 25 B.H.P., in good running order, with Generator and Scrubber complete. Also SET of Ejector 2-THROW PUMPS, capacity 9000 gals. per hour. Can be seen running by appointment at Downside Waterworks, Gurney Slade, Bath. Apply, DOWNSIDE WATER CO., Ltd., Stratton-on-the-Fosse, Bath. P6322 G

FOR SALE, 8ft. 6in. Diameter by 20ft. LANCASHIRE BOILER, with mountings and furnace fittings for hand firing, insured for 160 lb. working pressure; good condition.—Situated at HARWORTH COLLIERY, Bawtry, Yorks., where offers should be sent. 644 G

FOR SALE, the Largest Stock in the Country of Unused WROUGHT IRON SCREWED and SOCKETTED PIPES, both brand new and ex-Army stocks, as follows:—
11,000 feet, 8" Steam.
100,000 feet, 6" Water.
185,000 feet, 4" Water.
47,000 feet, 3" Water.
12,000 feet, 3" Steam.
40,000 feet, 2" Water.
30,000 feet, 1½" Water.
Also 1", 1¼", 2½".
10,000 feet of 4" Solid-Drawn Steel with loose flanges.
6000 feet, 8" Waddles Steel S. and P.
6000 feet, 6" Ditto.
GEORGE COHEN, SONS and CO., 600, Commercial-road, London, E. 14. 696 G

FOR SALE, THEODOLITES, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 325, High Holborn, W.C. (Opposite Gray's Inn-road).

FOR SALE, LEVELS, DRAWING INSTRUMENTS, SECOND-HAND. CLARKSON'S, 325, High Holborn, W.C. (Opposite Gray's Inn-road). Ex. G

FOR SALE, 1600 YARDS 18in. Gauge RAILWAY TRACK, iron sleepers, complete; seen by appointment.—S. W. TOMKINS, Estate Office, Bearley, Fletching, Sussex. 726 G

FOR SALE

FOR SALE, 14in. Three-screw STANLEY LEVEL, CASE and TRIPOD, perfect adjustment, £14.— Write, CALLAGHAN, 186, Haverstock-hill, N.W. 3. P6408 G

FOR SALE.—
ONE PUMPING SET, comprising two-cylinder "Aster" Engine, coupled direct to a 6in. Fulsometer Centrifugal Pump; capacity 700 galls. per minute to 50ft. head.
ONE 50 K.W. Belt-driven DYNAMO, by Newton, 440/460 volts D.C., 780 r.p.m., complete with Switchboard.
ONE 22 K.W. Belt-driven DYNAMO, by Hayward Bros., 220/230 volts, 900 r.p.m., D.C.
ONE 35 K.W. ELECTRIC GENERATOR, by the Phœnix Dynamo Mfg. Co., Bradford, 230 volts D.C., 152 amps., 850 r.p.m.
ONE 85 K.W. ELECTRIC GENERATOR, by the Brush Electrical Co., Loughborough, 230 volts D.C., 153 amps., 1100 r.p.m., complete with Slide Rails and Pulley.
1414ft. run of NEW 15in. CAST IRON DOUBLE-FLANGED PIPE, flanges faced and drilled to B.S.T. No. 2.
ONE NEW 18½in. centre LATHE, 10ft. 6in. sup bed, S.A., S.S., and S.C., by Robson; complete with countershaft.
ONE 36in. VERTICAL DRILLING MACHINE, to drill 12in., automatic and hand feeds, back-geared.
ONE Belt-driven NIBBLING MACHINE, by Burton, Griffiths; admits 30in. in mouth, overhead motion.
ONE Belt-driven EMERY FACE GRINDER, by Burton, Griffiths.
ONE Churchill 18in. DOUBLE-DISC GRINDER.
TWO No. 5 and ONE No. 24 ARBOR PRESSES.
STANLEY ENGINEERING CO., Bath. Ex. G

GENERATING SET 100 H.P. Petter Crude Oil Engine direct coupled to a 460-volt Dynamo.— CHICK, 58½a Market-place, Southwark, S.E. 1. P6406 G

LOCOMOTIVE, Manning-Wardle, 9in. Cylinders, 4ft. 9½in. gauge, nearly new, 120 lb. w.p.; bargain.—HARRY H. GARDAM and CO., Limited, Staines. 553 G

ONE Kendal and Gent VERTICAL MILLING MACHINE, fitted with automatic fed compound carriage, traverse, having three changes of speed gear and travelling length of 2ft. 6in., 6in. of table 36in., traverse of cross slide 2ft. 6in., variable-speed gear, having 18 changes from 20 to 300 revs. per min. In splendid condition. Apply— W. LAYLEY, Queen-street Ironworks, Chancery-lane, Ardwick, Manchester. 718 G

PLANO TYPE MILLER, BY INGERSOLL, TWO A TOOL HEADS ON CROSS RAIL, CAPACITY 4ft. BY 4ft. BY 12ft. PRICE £480, LOADED FREE ON RAIL TO AVOID REMOVAL. MARTIN BROS. (MACHINERY), LTD., 39, BRIDGE-STREET, MANCHESTER. 719 G

PORTABLE RAILWAY MATERIAL, WAGONS, TRACK, CROSSINGS, TURNTABLES, &c.— PLEASE NOTE.—We are now in a position to SUPPLY NEW MATERIAL of superior make from stock at lowest prices.—JOSEPH PUGSLEY and SONS, Ltd., Cattybrook Ironworks, Lawrence-hill, Bristol. Telegrams, "Pugsley, Bristol." Telephone No. 189. 385 G

PUMPING MACHINERY FOR SALE.

AVAILABLE FOR INSPECTION IN LONDON.

DUPLEX STEAM PUMPS.

Quantity and Description.

1 HORIZONTAL DUPLEX STEAM BOILER FEED PUMP, by Worthington, 6in. by 4in. by 6in., approx. 4000 gals. per hour, 2in. suction and delivery, 1in. steam pipe.

1 HORIZONTAL DUPLEX STEAM PUMP, by Tangye, date 1913, steam cylinder 6in. dia., water cylinder 4in. dia., stroke 10in., 3000 gals. per hour, 150ft. head, speed 40 double strokes per min., steam press. 60 lb. per sq. in., steam pipe 1in. dia., suction 3½in., delivery 3in.

1 HORIZONTAL DUPLEX STEAM PUMP, by Hayward-Tyler, 6in. by 6in. by 6in., 6000 gals. per hour, 60ft. head, speed 75 double strokes per min., steam press. 100 lb. sq. in., steam pipe 1½in. dia., suction 3½in., delivery 3in.

1 HORIZONTAL DUPLEX STEAM PUMP, by Worthington, 7½in. by 5in. by 6in., 4020 gals. per hour, 250ft. head, steam press. 100 lb. per sq. in., steam pipe 1½in. dia., suction and delivery 4in. dia.

PULSOMETER STEAM PUMPS.

2 PULSOMETER STEAM PUMPS, Size No. 2, 2800 gals. per hour, 50ft. head, steam pipe 1½in. dia., suction 2in. dia., discharge 1½in.

BELT-DRIVEN DUPLEX PUMPS.

1 HORIZONTAL BELT-DRIVEN DUPLEX PUMP, by Tangye, 6in. base, 10in. stroke, 9000 gals. per hour, 200ft. head, speed of pumps crank shaft 39 r.p.m., fast and loose driving pulleys 26in. dia. by 7in. face, 125 r.p.m., suction 5in. dia., delivery 4in.

1 HORIZONTAL BELT-DRIVEN DUPLEX PUMP, by Tangye, No. 52,975, 8in. bore, 10in. stroke, 19,800 gals. per hour, 200ft. head, speed of pumps crank shaft 45 r.p.m., fast and loose pulleys 4ft. dia. by 6in. face, 225 r.p.m., suction 7in. dia., delivery 6in.

VERTICAL BELT-DRIVEN PLUNGER PUMPS.

2 VERTICAL BELTDRIVEN GEARED TRIPLE-RAM PUMPS, by Fearn, 2500 gals. per hour, 250ft. head, dia. of plungers 4in., stroke 6in., suction and delivery 3in. dia., fast and loose pulleys 24in. dia. by 3 1-8in. face, 235 r.p.m., gear ratio 4 to 5.

2 VERTICAL BELT-DRIVEN GEARED TRIPLE-PLUNGER PUMPS, by Tangye, plungers 4in. dia. by 8in. stroke, 2500 gals. per hour, 350ft. head, speed of pump crank shaft 33 r.p.m., fast and loose pulleys 30in. dia. by 4½in. face, 210 r.p.m., suction and delivery 2½in. dia.

3 VERTICAL BELT-DRIVEN GEARED TRIPLE-PLUNGER PUMPS, by Tangye, plungers 7in. dia. by 6in. stroke, 4000 gals. per hour, 300ft. head, speed of pump crank shaft 60 r.p.m., fast and loose pulleys 36in. dia. by 6in. face, suction and delivery 4in. dia.

DEEP WELL PUMPS.

1 BELT-DRIVEN DEEP WELL PUMP HEAD GEAR, by the Deeming Co., U.S.A., Size No. 10, 600 gals. per hour, variable stroke 8in., 9in., 10in., speed of crank shaft 40 r.p.m., fast and loose pulleys 16in. dia. by 3in. face, gear ratio 6 to 1, suction 4½in. dia., delivery 2½in. dia., suitable for deep well tube pumps up to 300ft. deep.

1 BELT-DRIVEN GEARED DEEP WELL TUBE PUMP, by Duke and Ockenden, 5000 gals. per hour 250ft. head, 160 r.p.m., 15 B.H.P., complete with head gear, rods, tubes, pump chamber and suction box, 5in. suction, 4in. delivery.

Inspection is invited and permits to view, together with any further particulars and catalogue, may be obtained on application to—

HUGHES, BOLCKOW & CO., LTD., Agents for Leonard Aldridge and Ralph T. Hughes. "DEPT. E," 6, Laurence Pountney-hill, E.C. 4. Telephone, Central 54 (6 lines). Telegrams, "Huboldtop, Cannon, London." See also our announcement in last week's issue of "THE ENGINEER." Ex.

RAILWAY MATERIAL.— NEW and SECOND-HAND CREOSOTED SLEEPERS and CROSSING TIMBERS from large stocks. All sections of NEW and SECOND-HAND STEEL RAILS with accessories. R. H. NEAL and CO., Contractors' Engineers, 53 The Broadway, Ealing, London, W. 5. 356 G

For continuation of For Sale Advertisements see page 3.

Skimming Rivers for Irrigation Water.

A work of considerable interest to hydraulic engineers, which has recently been contributed to the papers of the Punjab Irrigation Branch by Mr. F. V. Elsden, executive engineer, deals with the effect of silt on irrigation works and with the possibilities of its exclusion from the canals.

The author naturally draws a distinction between the fine silt brought down by many rivers that is positively beneficial in its effects on account of its properties as a fertiliser, and the coarse sandy silt which is an unmitigated nuisance to both the canal engineer and the cultivator. It is, of course, this latter class of silt which it is the aim of every irrigation engineer to keep out of his canal system, and Mr. Elsden describes at some length the measures usually adopted for this purpose. His final conclusion is that there is little prospect of an improvement in the present unsatisfactory state of affairs so long as the canal headworks are constructed on the lines now generally accepted as correct, and he puts forward an alternative suggestion.

"It is," he remarks, "a fact well established by numerous experiments made on the Sirhind Canal that silt which is carried in suspension in a stream varies in both coarseness and amount in any vertical line, the finer grades and the lowest silt content being found in the upper layers of the water and the coarseness and amount increasing towards the bottom, until the heaviest grades, which may in a torrential stream even consist of shingle and boulders, occur in the very lowest layers of the stream, being in fact rolled along the bed rather than carried in suspension. . . . . Water flowing in a stream owes its power to carry silt in suspension to vertical eddies set up perhaps primarily by the roughness of the bed. It is found that for the same velocity a shallow stream will carry silt more readily than will a deep stream, a fact which may be explained as due to the vertical eddies, which are caused by the roughness of the bed, decreasing in strength as they rise towards the surface of the stream.

"A further explanation has been advanced by Mr. F. W. Schönemann, in a paper presented to the Punjab Engineering Congress, 1916, wherein he suggests, after Dupuit, that the greater silt-carrying power of shallow streams arises from the rate of change of velocity along a vertical being greater in shallow than in deep streams, an explanation which is in complete agreement with the hypothesis above postulated; that power to carry silt in suspension depends on the presence of vertical eddies, for it is evident that an increased rate of change of velocity or, what is the same thing, a greater difference in velocity in a vertical plane between adjacent filaments of water, will result in more powerful vertical eddies being set up, and, *ipso facto*, in an increased potentiality to carry silt.

"It follows, then, that eddies capable of supporting silt may arise, not only directly from the roughness of the bed, but also from anything which causes an increased rate of change of velocity along a vertical."

The author goes on to suggest that such conditions as those just outlined must prevail in the neighbourhood of the orthodox canal regulator, and that vertical eddies must develop as the water flows over the raised sill and carry comparatively heavy silt over from the river into the canal. In support of this contention he gives some calculations which show that it would be a physical impossibility in several typical cases for the canal to be supplied with only the surface layers of water from the river flume, although the actual outlet over the regulator is confined to the upper part of the stream section.

What is required for canals of any but the most modest dimensions is, Mr. Elsden urges, some form of headworks which, while permitting only a moderate velocity in the undersluice flume, shall ensure the arrival at the regulator of sufficient top water to supply the whole volume of discharge required for the canal, and this can evidently best be secured by aligning the face of the regulator along the plane which receives a maximum volume of top water per foot run. This plane is obviously the plane perpendicular to the direction of flow in the undersluice flume, and it therefore becomes apparent that the best position of the regulator is such that the face is at right angles to the direction of flow in the undersluice flume, instead of being nearly parallel with it, as has been customary up to this time. The regulator must also have a raised sill, the level of which shall be the lowest level from which water can be drawn without admitting water which contains an excessive silt charge, and adequate means must be provided for the egress of the bottom water, which is not wanted in the canal, from the undersluice flume.

All this, Mr. Elsden asserts, points clearly to the necessity for the canal head regulator being superimposed on the undersluices, the remaining features of the headworks, in general arrangement, being left much as they are at present designed, and the regulator sill being, say, one-third of the depth of flow below normal water surface level in the undersluice flume. In this way the top three or four feet of the water flowing down the undersluice flume will be skimmed off and passed into the canal, while the water in the remainder of the depth will be passed, with its silt, through the undersluices, and neither bottom water nor bottom silt will get into the canal.

Such a design naturally requires that a flow of surplus water be maintained in the undersluice flume, and it might be objected that there may not always be water to spare for this purpose. This objection, however, has no real weight, for when the supply of water is restricted it is most unlikely that it will be carrying a heavy burden of silt, and in such circumstances there will be no harm in closing the undersluices completely, for though this will entail the admission of bottom as well as top water, this bottom water will carry with it no silt which can do any harm. By this expedient of superimposing the canal head regulator on the undersluices, the supply of true top water to the canal will be maintained in a natural way, and there will be no turbulent flow due to sudden changes of direction. Twenty years ago such structure would have been somewhat difficult to carry out in at all a satisfactory manner, but the developments which have taken place in the use of reinforced concrete have much simplified the problem which does not now present any really serious difficulties.

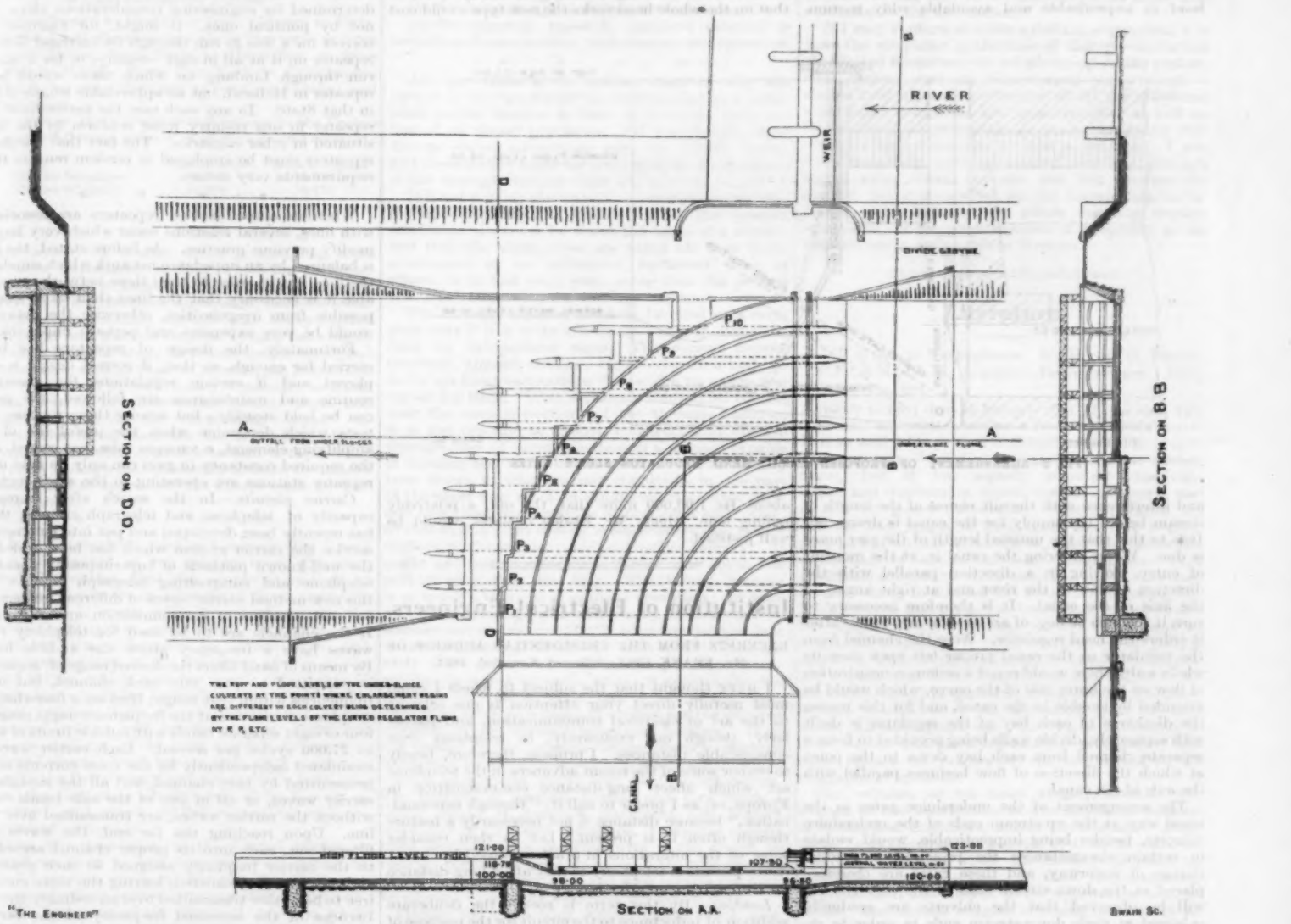


FIG. 1—PLAN AND SECTIONS OF PROPOSED CANAL HEAD REGULATOR

In order to show how it is proposed to carry out the design in practice the author has worked out a general plan, which we reproduce in Fig. 1, of a canal head regulator based on the principles he has propounded. The regulator sluice gates are of an entirely novel design, and consist, as shown in the detail drawing in Fig. 2, of two parts—the sluice gate proper and what may be termed the skimmer gate—the latter being hinged at its lower edge, about which it can rotate upwards in order to adjust to varying water levels the height at which water is taken into the canal. This arrangement makes it possible to alter the level of the regulator sill while preserving a sharp cutwater against the current, thus reducing to a minimum eddies caused by the presence of the gate, and giving a gradual entry to the undersluice culverts.

It might seem that the skimmer gate could be used for the double purpose of regulating supply and adjusting sill height, and this would in fact be the simplest form of gate, but it is found that such an arrangement would involve either absurdly small

spans or most inconveniently high pressures on the gate and its operating mechanism, and it will be more convenient in practice to admit pressure to both sides of the skimmer gate in order to lighten it and the standing gear for operating it. This can be most conveniently done by means of an ordinary sluice gate, the opening of which is so adjusted as to head up water on the down-stream side of the skimmer gate to a level little below that on its up-stream side. Two ways of operating the gates present themselves. They might be operated by entirely separate gear, leaving to the regulating staff the task of adjusting the levels of the two gates, or, preferably, they may be interconnected, the standing gear which operates the skimmer gate operating also the sluice gate, and their relative motion being such that the amount of gate opening and the height of the skimmer gate are always in their correct relation. In this way the operation of the two sets of gates would be automatic, depending on correct design of the standing gear and not at all on the intelligence of the regulating staff, whose task would thus be limited to keeping the canal discharge correct, an operation which does not call for a high degree of intelligence or training.

Throughout the design care has been taken to make all cutwaters approximate to streamline form, and all changes of section of flow so gradual as to avoid as far as possible dissipation of energy and loss of head in unprofitable and avoidable eddy motion, in the water level above the weir than in the case of existing headworks. For this reason there can be no doubt that the most convenient form of weir would be one with its crest as low as possible, at the same elevation as the floor of the undersluice flume, and provided throughout its entire length with sluice gates which can be closed to maintain a sufficiently high level to feed the canal, or opened to permit a flood to pass without excessive heading up.

Some indication of the cost of the proposed type of headworks as compared with the current type is given by the author as follows:—

The cost of the undersluices and head regulator will be considerably increased, and is estimated for the example shown in the drawing to amount to Rs. 15,00,000, as compared with Rs. 9,00,000, which was about the cost of a regulator and undersluices of the ordinary type to suit the same conditions, showing an extra cost of Rs. 6,00,000. Coming to the weir, the cost for a weir of the ordinary type fitted with drop shutters was about Rs. 850 per lineal foot of waterway, or, in the example dealt with, Rs. 34,00,000, the waterway being 4000ft. long. For a low-level closed weir fitted with Stoney sluice gates throughout, the length of waterway being 2400ft. and the cost per lineal foot Rs. 1200 complete, the total would be Rs. 28,80,000, or, in round figures, Rs. 29,00,000, showing a saving of Rs. 5,00,000, so that on the whole headworks the new type would cost about Rs. 1,00,000 more than the old, a relatively trifling sum, which, Mr. Elsden declares, would be well justified.

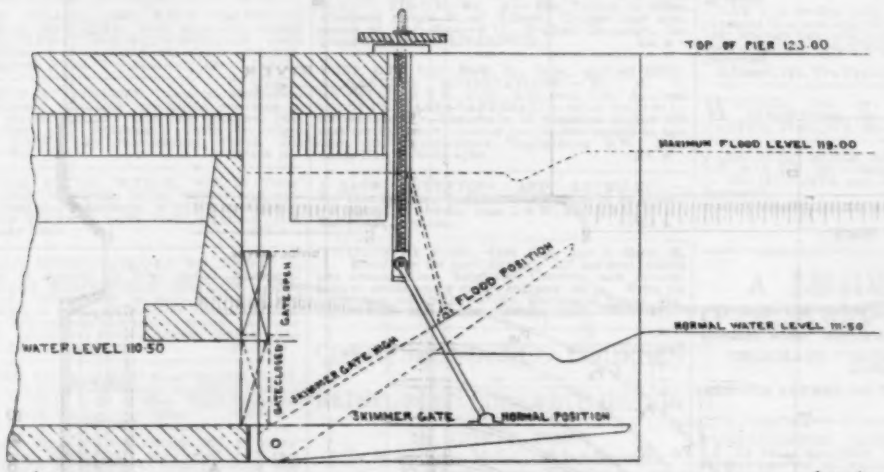


FIG. 2—ARRANGEMENT OF PROPOSED CANAL HEAD REGULATOR SLUICE GATES

and interference with the silt *régime* of the length of stream before the supply for the canal is drawn off. It is to this that the unusual length of the pier noses is due. Water entering the canal is, at the moment of entry, flowing in a direction parallel with the direction of flow in the river and at right angles to the axis of the canal. It is therefore necessary to turn it through 90 deg. of arc as soon as possible after it enters the head regulator. Were the channel from the regulator to the canal proper left open over its whole width there would result a serious concentration of flow on the outer side of the curve, which would be attended by trouble in the canal, and for this reason the discharge of each bay of the regulator is dealt with separately, divide walls being provided to form a separate channel from each bay down to the point at which the direction of flow becomes parallel with the axis of the canal.

The arrangement of the undersluice gates in the usual way at the up-stream ends of the undersluice culverts, besides being impracticable, would violate in certain circumstances the principle of gradual change of waterway, and these gates are therefore placed at the down-stream ends of the culverts. It will be observed that the culverts are gradually enlarged at their down-stream ends in order to reconvert velocity head into static head, and reduce to a minimum the amount of head which is totally lost in the passage through the culverts. The floor of the regulator, which is also the roof of the undersluice culverts, consists of a slab of reinforced concrete, which is peculiar, in that the worst loading to which it is liable to be subjected is in an upward direction, on the assumption that the canal is closed during a maximum flood. Double reinforcement is therefore needed, and this slab must also be tied down into the foundations of the structure by means of reinforcing rods passing down the piers well into the foundations. The piers will therefore be of concrete, but should be faced with hard ashlar dressed to a smooth face in order to withstand wear and keep the coefficient of friction low.

The position of the canal head regulator superimposed on the undersluices makes it desirable to fix the lowest sill considerably higher than need be done in a regulator of the old type, in order to keep within reasonable limits the pressure to which the culvert roof will be subjected. At the same time the limit of heading up during a high flood cannot be indefinitely raised, and the result of these two limitations is that the type of head regulator advocated by Mr. Elsden will permit of less range of fluctuation

Institution of Electrical Engineers.

EXCERPTS FROM THE PRESIDENTIAL ADDRESS OF MR. FRANK GILL, delivered Nov. 2nd, 1922.

I HAVE thought that the subject to which I could most usefully direct your attention is one relating to the art of electrical communication, and particularly, though not exclusively, to telephony over considerable distances. I propose, therefore, briefly to review some of the recent advances in the telephone art which affect long-distance communication in Europe, or, as I prefer to call it, "through communication," because distance is not necessarily a feature though often it is present. Let us then consider some of the alterations in practice caused by recent developments in telephony as they affect long-distance or through communication.

Loading.—By this term is meant the deliberate addition of inductance to the circuit for the purpose of increasing the distance over which satisfactory speech is feasible. Such inductance may be in the form of evenly distributed inductance effected by wrapping the copper conductor with magnetic material, such as fine iron wire, or, and more commonly, may be in the form of lumped inductances obtained by inserting in series in the circuit at intervals coils having the required inductance and a minimum resistance. It was in 1887 that Oliver Heaviside pointed out that the addition of inductance by either of these methods—inductance being then thought harmful—would be beneficial to the transmission of speech. The addition of inductance to circuits, whether open wire or cable, affords a means of greatly extending the distance to which speech is possible, and of reducing the copper required to transmit speech over such distances as were previously feasible. But while loading reduces frequency distortion on the cable circuit, it increases this form of distortion on the open wire circuit; also by increasing the voltage in the circuit, it augments cross-talk, and it reduces the speed of propagation in the circuit.

So far as open lines are concerned, the reactions on the general plant caused by loading are that a higher class of construction, including transposition, and maintenance is required to avoid cross-talk and to keep up the insulation, for loaded lines are much more susceptible to reduction in transmission efficiency due to lowered insulation than are non-loaded lines. With poor maintenance it may well be that the number of days in the year during which the improvement due to loading is gained is not sufficient to pay for the cost of loading.

Repeaters.—Although the telephone repeater has been in service since 1905, it is only since 1914 that the thermionic repeater—which followed the introduction of the grid or third element by de Forest into the two-element thermionic valve of Fleming—has been employed and the great impetus to its use has only been given during the last five years or so. The fact that a three-electrode vacuum tube acts as an amplifier of speech currents has led to an idea that a telephone repeater begins and ends in a device which relays the received current very much as does an electro-magnetic relay; but the telephone repeater has many important conditions besides the amplifying one, and the fact that the reactions on telephone practice, due to the advent of the practical telephone repeater, have been and will be of very special importance makes it worth while to devote some little time to their consideration.

When repeaters are employed in any line they must, of course, be located at the right positions determined by engineering considerations alone and not by political ones. It might, for example, be correct for a line to run through Switzerland with no repeater on it at all in that country, or for a line to run through Limburg on which there would be a repeater in Holland, but no appreciable length of line in that State. In any such case the networks at the repeater in one country must conform to the lines situated in other countries. The fact that telephone repeaters must be employed in tandem renders their requirements very severe.

* * * *

When in actual service repeaters are associated with lines, several reactions occur which very largely modify previous practice. As before stated, the line is balanced by an impedance network which simulates the line, but in order to keep these networks practicable it is necessary that the lines shall be as free as possible from irregularities, otherwise the networks would be very expensive and perhaps impossible.

Fortunately, the design of repeaters has been carried far enough, so that, if correct design is employed and if certain regulations for operating routine and maintenance are followed, the gains can be held steadily; but among those routines are tests which determine when the useful life of an amplifying elememt, a vacuum tube, has ceased, and the required constancy in gain can only be held if all repeater stations are operating to the same routine.

Carrier circuits.—In the search after increased capacity of telephone and telegraph circuits, there has recently been developed and put into commercial service the carrier system which has been added to the well-known methods of superimposing phantom telephone and compositing telegraph circuits. In this new method carrier waves of different frequencies for each channel of communication are generated. If the channels are to be used for telephony such waves have a frequency above the audible limit. By means of band filters the desired range of frequency is permitted to pass into each channel, but only frequencies within that range; thus on a four-channel telephone carrier circuit the frequencies might range in four or eight separate bands with outside limits of 4000 to 27,000 cycles per second. Each carrier wave is modulated independently by the voice currents to be transmitted by that channel, and all the modulated carrier waves, or all of one of the side bands only, without the carrier waves, are transmitted over the line. Upon reaching the far end, the waves are filtered out, each into its proper channel according to the carrier frequency assigned to each channel, and are then demodulated, leaving the voice current free to be farther transmitted over an ordinary circuit. Because of the increased frequency of the carrier waves, greater attenuation occurs with them than with the voice waves, and carrier current repeaters must be equipped more frequently than voice current repeaters; also, for the same reason, carrier currents cannot be transmitted over ordinary loaded lines, which, it will be remembered, cut off at frequencies within the audible range. Hence, if loaded carrier circuits are required, they must be specially treated. Special treatment is also needed in the construction and maintenance of carrier lines and equipment, and because the equipment is expensive such lines must be of considerable length in order to be economical.

As an illustration of the advantages to be gained by using the latest development, the following may be quoted. On the New York-San Francisco line the circuits are of open wire from Harrisburgh to San Francisco, about 2500 miles (4050 kiloms.) direct distance apart. On four conductors on this route the loads carried are:—

2 physical telephone circuits,
1 phantom telephone circuit,
4 earthed telegraph circuits, and
a varying number of carrier telegraph circuits ranging from 6 to 20.

Two of the sections on this route in detail are:—

Between Chicago and Omaha.—450 miles (729

kiloms.) direct distance apart, four open wire conductors carry :

2 physical telephone circuits,
1 phantom telephone circuit,
4 earthed telegraph circuits which can be worked either 1 way or 2 way at will,
20 2-way carrier telegraph circuits.

27 total circuits on 4 wires.

Between Chicago and Pittsburg.—450 miles (729 kiloms.) apart, eight open wire conductors carry :

4 physical telephone circuits,
4 halves of phantom telephone circuits (equivalent to 2 circuits).
8 earthed telegraph circuits which can be worked either 1 way or 2 way at will,
37 2-way carrier telegraph circuits.

53 total circuits on 8 wires.

From another route we take the following :

Between New York and Philadelphia.—90 miles (145 kiloms.) apart, two conductors in cable carry, though not by carrier circuits :

1 physical telephone circuit,
30 special signalling circuits.

31 total circuits on 2 wires.

From Chicago to Omaha or from Chicago to Pittsburg the direct distances are about the same as from Paris to Berlin, from Paris to Marseilles, or from London to Milan. From New York to Philadelphia is about the same distance as between London and Birmingham.

At present there are in actual service in the United States the following miles of carrier route and channel :

	Miles of route.	Miles of channel.
Carrier telephone	4,776	16,576
Carrier telegraph	10,919	78,870
Total	15,695	95,446

* * * *

Interference.—A matter which is assuming more and more importance is that which in the communication art is termed "interference," meaning by that term the reactions which occur between weak-current communication circuits and heavy-current light, power and traction circuits. Much has already been done by joint study to reduce interference, and in some cases, such as those of electrolysis, it has been found economical to the "heavy" industry to avoid certain defects in construction which were first brought to light by the complaining "light" industry. But in all cases the lesson is always being so pressed home, that success is certain to come when each party makes a real endeavour to learn the other's problems and to appreciate the efforts made by him to solve them.

* * * *

It is so in telephony, and as I assume that I may take it for granted, at any rate by those who have studied the matter, that the telephone systems of the United States are in advance of those operating in Europe, it is worth while to see wherein lie the differences—altogether apart from ownership—and particularly the differences in organisation, and to obtain some idea of the telephone system in the United States, which now has nearly two-thirds of the telephones installed throughout the whole world. In that country there are at present over 10,000 companies owning and operating over 14,000,000 telephone stations. That total number divides into two broad classes : those having some kind of connection with the Bell System, and those which have not. Again, the first class divides into those known as Bell-owned, and others as Bell-connecting with an independent ownership.

Taking the population of the United States at 109 millions there is now one telephone station to every 7.7 persons, while in the year 1900 there was only one telephone station to every fifty-six persons. Since the beginning of the twentieth century, while the population has increased by 45 per cent. and the volume of general business—judged by the best data available—by 100 per cent., the number of telephone stations has increased by over 900 per cent.

While there are many telephones which are not part of the Bell System, the great majority (97 per cent.) are part of that organisation of companies, and, further, it may be stated that with a few exceptions, those companies which are not part of that system are, on the average, a collection of small concerns. In what follows, and generally in connection with the expression "telephony in the United States," the Bell System is referred to.

There are five outstanding features in the organisation of the Bell System, and I think it may be said that these features are essential in any effective organisation for telephony on an extended scale.

The five features are :—

(1) Local operating organisations, thus making for decentralisation. These organisations, or companies, possess large measures of authority.

(2) A central administrative direction and control over the local organisations.

(3) A long-distance organisation constructing and operating the long lines by which the local organisations effect intercommunication.

(4) Control of the manufacturing organisation.

(5) A central organisation for scientific research, development of apparatus and technique of construction, maintenance and operation.

In Europe, generally speaking, and considering the nations separately, we find :—

(1) An organisation having a central authority with no separate local authorities.

(2) A series of administrative areas charged with the duty of maintaining the service under the central authority.

(3) No one department charged with the duty of through business.

(4) No control over manufacture.

When we consider Europe as a whole we find :—

(1) A number, about forty, of self-contained local operating organisations each, in the majority of cases, conducting a local business and a through business within its area, also that part of the international through business which lies within its own borders.

(2) No organisation controlling or co-ordinating the various local operating organisations, which yet have to function as a whole.

(3) No means of keeping the separate organisations in touch with each other, and no systematic means of adjusting differences in matters of daily practices.

(4) No organisation of any kind which handles and cares for the through business as a whole.

(5) No common agreement as to manufacture.

(6) No common research, standard practice or technique of construction, maintenance and operation.

* * * *

And yet there is no reason whatever why the service in Europe should not be extended in a somewhat similar fashion to that in America ; from the fact of its denser population and less distant cities, Europe enjoys advantages over the United States, and these should make for much greater development of the through business than she now has.

It is not putting the matter too strongly to say that through-telephony in Europe under the present conditions can never be worth the name of a service, and that the alternatives are either for ever to be condemned to an ineffective, inefficient state of affairs, or to find some plan, other than the present one, for dealing with the through business.

The through business must be handled as a complete unit if it is to be efficiently done ; it cannot be done by independent units. The correct course, therefore, appears obvious, viz., to depute a body to do for all European nations that which no one nation can do for itself. With sectional, non-unified control over the various portions of the through business, it is not possible to design, construct and operate through lines of communication in a manner capable of meeting the needs of the public. It has already been shown in what manner conditions in one part of the plant may react on conditions at another part, and how these parts may be distant from each other, so that in fact what is done in one country may render ineffective the efforts made in another country. It ought not to be necessary to labour this point, but perhaps an analogy may help. The through business is as much a unity as is military operation ; we have seen the advantage gained by unity of command in warfare and no one would now advocate independent multi-commands such as were seen in 1914 and the early years of the war. If it was possible for the nations to agree on such unity of control for the purposes of war, it ought not to be beyond their powers to agree to a unity of control for the efficient working of the through-telephone business. It is not enough for the separate organisations to attempt to agree to a code of rules to which each shall subscribe—such an attempt would only be to court failure. The business is varying, flexible and very much a living thing ; it demands intelligent and prompt treatment of its many variations, it requires control from central points carrying with it the power to instruct persons at great distance in the routines and duties they are to perform, and such control can only be effected by a living authority always on duty.

Besides the engineering considerations which have been dealt with, there are weighty reasons connected with the matters of circuit lay-out, business policy, rates and operating, about which much might be said, showing the impossibility of giving an adequate through service without unity of control, but this is not the place to deal with them.

It is easier to analyse the conditions and to state the fundamental requirements for efficiency, than it is to propound a scheme for an effective organisation. The alternative suggestions which present themselves are :—

(1) To operate all the through business both within and between the various countries in Europe by a single long-lines company working under licences from the various Governments, taking the calls from the local originating organisations, and being entirely responsible for them until turned over to the local receiving organisation.

(2) The second alternative is for the various Governments to form what would, in effect, be a private company or commission, of which the Governments only would be the stock-holders, to do the work described in the first alternative, and from each subscribing Government the commission would derive its authority in that country. The commission being supplied by funds, on some agreed plan of participation by each Government, would be the sole judges of the plant to be constructed and operated, within the scope of the moneys put at its disposal, and it would assume the ordinary responsibilities of a board of directors of a public company, carrying out all the necessary functions and periodically reporting results to those who supply the capital. It might be that all plant constructed in any country should belong to that country, and that the capital to be provided by that country should be its proper share depending upon the plant within its own borders.

In addition, the commission could hire facilities, where economical, from the local administrations in cases where it would not be economical for the commission to construct its own lines. Such lines could be hired on a permanent or temporary basis.

(3) The third alternative is frankly one of a temporising nature, being intended only to cover a study of this difficult problem. It is that the various operating telephone authorities should form themselves into an association for the purpose of studying this and other matters. Such association might come about gradually if necessary, and regular meetings might be fixed for the purpose of studying a prearranged programme, which, apart from the larger question as to how the through business should be operated, might include the fixing of standards of measurement, performance and methods to be recommended to all, and to be enforceable on those who subscribe to the association.

If I may venture to make a definite suggestion, it is that the telephone authorities of Europe—including the United Kingdom—as telephone-operating authorities rather than as Government departments—should hold an early conference of all the telephone authorities, companies and municipalities as well as Government departments, to study in detail this problem and endeavour to find a solution. I am convinced that unity of control over the through traffic must obtain in the end, but whether the through traffic is handled by one organisation or by many, there are matters which urgently require agreement for the improvement of telephony as an efficient agent for service in Europe.

Literature.

A Life of George Westinghouse. By HENRY G. PROUT, C.E., A.M., LL.D. London : Benn Brothers. 1922. Price 18s. net.

RARELY indeed does it happen that of one man two "Lives" are written within a few years of his death. It is as well perhaps that it should be so. The almost contemporary "Life" has certain manifest advantages, but it has equally manifest disadvantages, and duplication should not be necessary, and is not, in general, desirable. Contemporaries are not the best judges of their great men ; it is their part to put on record the facts, once, and leave the estimation of effects to later biographers. Yet justifiable exceptions there may be, and in this case we are willing to absolve Dr. Prout for following Mr. Leup. In the first place, Dr. Prout does but carry out the purpose of the American Society of Mechanical Engineers to publish a series of Lives of its greater members, and, in the second, Mr. Leup's biography left a good deal to be desired. It was written with too much regard to dramatic effect and all too often became journaleso of the advanced type, or, still worse, kinematograph-eee. Dr. Prout's work is a more serious and more trustworthy production, and must replace its predecessor in the regard of all biographical students.

The volume, as we have already hinted, was written to the instructions of the American Society of Mechanical Engineers, and is the second—"John Fritz" was the first—of a series of Lives of eminent American engineers which the Society proposes to publish as occasion arises. In these circumstances, its production was subject to the approval of a committee. Can anyone imagine anything more likely to ruin a biography ! It is vastly to the credit of the committee, no less than to the author, that so little harm has been done, and yet one cannot but feel now and again that had Dr. Prout been given a perfectly free hand he might have done better still. There is not infrequently a dry matter-of-factness which suggests committee influence, and one sometimes wishes for a little less rigid accuracy and a little more imagination. But perchance it is better to leave such things to the future. If distant ages judge George Westinghouse great, some later Smiles will arrive to illuminate his career in fascinating English and with such an indifference to meticulous precision as may be forgiven in an artist, but is wholly out of place in a committee.

The outstanding characteristic of the present volume is its careful and skilful handling of technical matters. It deals, fairly intimately, with all the more important Westinghouse inventions, and it discusses the technical subjects with perfect correctness, but with such a regard for salient and elemental facts that the lay reader may readily follow it. To do this requires no small skill, and Dr. Prout is heartily to be congratulated on his achievement. Biographies should not be esoteric. They should welcome all, the lay as warmly as the professional. They have their own particular work to do in this world. It is their business to encourage endeavour by exhibiting the

success of great men, and it would be wrong to shut out one section of readers by an unnecessary parade of technicalities. Hence, we hold the committee of the American Society of Mechanical Engineers right in repelling the temptation to deal with George Westinghouse's inventions in a manner that would have reserved the understanding of them to the arcana of engineers. It has opened the door to the comprehension of the great inventor's work to all and sundry. That is a service of no mean order. Westinghouse is a familiar name the world over, but we suppose few of those who use it know any of the details of the inventions which made it famous in all the continents. The book gives them facilities for learning, and must place the fame of George Westinghouse on a surer foundation by replacing the common chatter of the railway carriage and the shouting of sky-signs with at least an elementary understanding of the technicalities of the inventor's work.

We make no apology now for not reviewing Westinghouse's career as it is set forth by Dr. Prout. That is a subject that has been frequently dealt with during past but still recent years. It seems to us more important to say that here we have a very much better biography than its predecessor, a biography, moreover, which is written with a full technical understanding of Westinghouse's inventions, and with an intimate personal knowledge of the man himself. It misses being a great biography—as, for example, amongst moderns, the Life of Pasteur—but it does so by a narrow margin, and we suspect mainly because, being written for an engineering society, a measure of technical restraint was inevitable.

SHORT NOTICES.

The Electrical Handling of Materials (Vol. III., *Electric Cranes*). By H. H. Broughton. London: Benn Bros., Limited. Price 50s. net.—This book is a revised edition of the author's book on electric cranes and hoists. Many cranes and crane mechanisms are described and illustrated. There are chapters on crane arrangements, arrangement of crane mechanisms, design of crane mechanisms, overhead travelling cranes and gantry cranes, jib cranes, building slip equipments, fitting-out cranes, floating cranes, large revolving cantilever cranes, steelwork cranes, charging machines, the erection of the Quebec Bridge, code of safety standards for cranes, specifications and crane questionnaires. Crane designers and others interested in the subject will find much useful information in this new volume.

Electrical Circuits and Circuit Connections. By William Rushton Bowker. London: Crosby Lockwood and Son. Price 15s. net.—The third edition of this book differs from its predecessor in that it is larger and covers a wider field. Many useful wiring diagrams are given for dynamos and motors, controllers, and general traction equipments. There are also wiring diagrams for electric lighting and other plants with batteries, connections for reversible boosters, transformers, rotary converters, alternators and alternating-current switchboards, testing panels, and so forth. The book, which is written on entirely practical lines, ought to be of service to many who are engaged in electrical work, and especially those associated with generating stations and sub-stations and the use of electric power.

The Institution of Civil Engineers.

THE first meeting of the Manchester and District Association of the Institution of Civil Engineers for the session was held on Wednesday, the 25th ult., when Mr. J. B. L. Meek, the President, gave his inaugural address, from which we take the following excerpts:—

In schemes of main drainage constructed from fifty or sixty years ago up to the present time, every endeavour appears to have been made to proportion the sewers in accordance with the work they had to perform. The task of the earlier drainage engineers must have been far more difficult than falls to the lot of the present-day engineer, as the former had not the statistics at their disposal which their more fortunate successors possess. No difficulty appears to have arisen, owing to the inability of any system of sewers to carry off the actual sewage and manufacturing wastes, but trouble seems to have arisen in many cases by reason of flooding in times of rainfall. The reason of this, I think, is plain, as the present population of the town to be drained was generally easily ascertainable and calculations of sufficient accuracy to deal with the dry-weather flow for some years ahead could be made from census returns, taking into consideration such facts as to whether the trade of the town was likely to develop rapidly or to remain stationary, thus arriving at a very fairly accurate idea of the amount of sewage proper that the system would be called upon to cope with. The calculation of the amount of rainfall that a sewer may be called upon to discharge is, however, a much more difficult matter than the assessment of the dry-weather flow, and it must be remembered that the amount of storm water fixes the size of the sewer and thus in a great measure determines the cost of the scheme; also, under the Public Health Acts, an authority is reponsible for the proper drainage of its area, and sewers constructed of an inadequate size might result in the authority having to pay heavy damages for destruction caused by floods; while, on the other hand, sewers constructed too large would be a waste of public money.

The amounts of rainfall provided for in various sewerage schemes shows the differences that obtained and the lack of uniformity there has been in dealing with this matter. Thus, in the first London scheme a volume of rainfall equal to ½in. per day was provided for, to be carried off during the six hours of maximum flow of sewage—that was, that the system was to be capable of dealing with half the daily flow of sewage in six hours, plus rainfall at the rate of ½in. per day. In later years, the London system has been considerably enlarged, and now appears to be capable of dealing with more than ½in. of rainfall over the whole area in twenty-four hours. The Glasgow system was designed to convey about ½in. of rainfall per day reaching the sewers, which would mean a considerably greater actual fall of rain in the twenty-four hours than ½in. In Aberdeen, ½in. of rainfall per hour was taken as the standard falling, and coefficients of that quantity were adopted to determine the amount of rainfall actually reaching the sewers from given areas. In the first Manchester scheme the rainfall to be carried off was computed to be ½in. in twenty-four hours. This, however, was found to be insufficient, and a greater amount was allowed for in the present scheme.

It is now generally recognised that it is not the amount of rain falling in twenty-four hours that affects sewers, so much as the intensity of rainfall over a short period. This intensity of rainfall can be measured and recorded by automatic rain gauges, and such records are of inestimable value to the engineer entrusted with the design of a drainage scheme. If only public bodies recognised the utility of such records, I feel sure that many more automatic rain gauges would be installed than exist at the present time.

Supposing that over an area to be drained an accurate record of the intensity of rainfall has been kept for a number of years, and such records are then plotted on a diagram to show the intensity of a great number of storms of various durations of time, a line can then be laid down on the diagram representing the intensity of rainfall that it is reasonable to provide for over the given area. In deciding on this line, all normal storms must be provided for, and it is safer to include fairly frequently recurring storms of more than normal intensity, but it would be manifestly unreasonable to provide for the worst storms that had ever occurred, and that in all probability would not occur again for many years, if at all. Having now a diagram with the line of rainfall to be considered passing through the ordinates, representing the duration of the rainfall at that intensity, it is applied by calculating the time of concentration for a sewer and obtaining from the diagram the intensity of rainfall corresponding to such time. The time of concentration is the time taken for storm water to travel from the most distant point of the area to be drained to the outfall of the sewer, plus the time it takes for the sewer to fill. This time will represent the duration of the worst storm that need be provided for, and the intensity of such storm can be obtained from the diagram.

The utility of such a diagram does not end, however, with the design of the sewer, but a record remains built up from actual rain gauge readings, showing clearly what amount of rainfall a certain sewer was designed to discharge and the reasons why such an amount was decided on. In the event of claims being made against a drainage authority for damage due to flooding, it appears to me that such a record would be of the greatest value in determining whether the authority had made reasonable provision to drain its area or not.

As an example of how this method of computing rainfall from the intensity of the fall compares with the older method of computing it by the fall in twenty-four hours, it may be mentioned that taking eighteen fair-sized areas in Manchester, the average rainfall provided for is of the intensity of .4in. per hour, which is very different thing from ½in. in twenty-four hours; but perhaps a better comparison would be that the outfall sewers can now discharge approximately 1½in. of rainfall in twenty-four hours from the whole area they drain. The greatest rainfall actually taking place on the area in twenty-four hours during each year from 1905 to 1921 has been ascertained, and the average over these years gives a figure of 1.3in. in twenty-four hours, which shows that by dealing with the intensity of rainfall for each tributary sewer, which is a varying figure in each case, the capacity of the outfall sewers agrees very well with the actual conditions prevailing when the area is considered as a whole. These figures apply to actual rain falling, and not to the amount that reaches the sewers.

The amount of rain actually falling on the surface of the land is a greater amount than that reaching the sewers, and it is a matter of difficulty to decide on the proportion of rainfall that actually runs off the surface and reaches the sewers. In considering this matter, many factors have to be reviewed, such as the degree of permeability of the ground, the shape and slope of the ground in reference to the sewer draining it, evaporation and whether rain occurs steadily over a long period or a heavy fall takes place after a dry period. The usual method adopted at present to determine the proportion of rainfall actually reaching the sewers is to fix more or less empirical coefficients depending on the population of the area under consideration and ranging from a high coefficient in a crowded built-up area to a low one in an agricultural area. As far as I am aware, very few experiments have been conducted to verify these coefficients, and a wide field is open to the experimenter in this line, for it is a matter of importance that there should be some fairly well-established data on this matter. It is not always possible to conduct such experiments on areas that are actually about to be drained, as sewers are generally constructed to meet requirements that may exist in the future, and do not obtain at the time of construction. Moreover, such experiments are difficult to carry out, as it is not always easy or possible to isolate an area and be sure that all connections from that area to the sewer are accounted for, and that no unknown sources are contributing to the flow. Again, it is essential that such experiments be continued over a lengthy period of time in order that all seasonal fluctuations may be accounted for. It is also necessary that the sewer under observation should have a free outlet, so that the gaugings of flow may be accurate, and this condition may entail some structural alteration to the sewer, of a minor character, it is true, but all these things take time. It therefore appears that the best field for such experiments obtains in towns embracing within their boundaries both densely populated built-up areas and areas consisting of park land very sparsely built upon. If such experiments were conducted and the gaugings in the sewer compared with the readings of automatic rain gauges set up in the same area, a very valuable set of coefficients would be obtained. In fact, I think it is not too much to say that if such coefficients were available from a number of towns, together with automatic rain gauge records, for a period of years on the area to be drained, a great step would have been taken to make the science of main drainage a much more exact science that it is at the present day.

With regard to roads, the perfect road to meet all conditions has not yet been found, and it is difficult to see how any one road can be made to satisfy such opposite conditions as those required by motor and horse-drawn vehicles. The only solution at the present time appears to be to treat every road on its merits and to put down the material best suited to the traffic that will most frequently use it, to the position in which it is placed, and having regard to the cost in relation to the life of the road. However, the engineer responsible for the upkeep of a road is not always able to put down the material he would like, but often has to do the best he can with the money available. If through motor traffic is to continue as at present, let alone increase, there is no doubt that many country roads lying between industrial centres will have to be reconstructed at an expenditure of a large sum of money.

For some years entirely new roads have been laid out of ever-increasing widths. A few years ago 100ft. was considered to be a large width for a road. Now, roads are being provided with a greater width than this, and in prospective roads widths up to 200ft. are being mooted. By these increased widths provision is being made for a greater volume of the same sort of traffic that has caused congestion on our present roads. It is true that a wide road will deal with a greater volume of traffic than a narrow road, but if the traffic continues to increase, it is only a question of time before the wide roads become as congested as our present roads are. It is to be assumed that development will take place in the areas adjoining these new roads, and that dwellings and business premises will be erected alongside such roads; in fact, in time they may become busy commercial thoroughfares. Imagine a road 100ft. wide, with provision for six lines of traffic on the carriageway, becoming the main thoroughfare of a populous area, and the traffic using that road to have so increased as to have caused congestion, for these roads will be open to all classes of traffic, both fast and slow, as are our present roads, and it is only a question of the rate of increase of traffic that will decide when a state of congestion will occur. When such a road does become congested, what is the remedy? To widen it still further? There must, however, surely come an end to any race between the increase of traffic and the width of roads, because pedestrians have a right to cross the roads, and to cross one of these wide roads congested with traffic would be a perilous operation and would almost justify the construction of bridges at frequent intervals, or subways, to provide safe crossing places. The construction of these very wide roads with their possibly attendant subways and bridges, means a vast outlay of money. Would it not be better to construct entirely separate roads to accommodate the greater proportion of the motor traffic, constructing the ordinary roads of only sufficient width to carry ordinary domestic mixed traffic? These separate motor roads need not be of a great width, as most of the traffic using them would be travelling at a more or less uniform speed, and the disadvantage of vehicles of all speeds using the one road would disappear. I should suggest a width of 30ft. as ample. They would be fenced in, and frequent junctions arranged with the ordinary roads to enable traffic to travel from door to door, and all crossings would be by means of bridges, while the surfaces of these roads would be constructed for motor traffic only.

The Motor Car Shows.

No. II.*

In spite of the depressing industrial conditions which are still prevalent, the interest taken by the public in the annual motor shows promoted by the Society of Motor Manufacturers and Traders seems to be as keen as ever, and judging from the amount of business done during the last few days by the leading British manufacturers, there is an optimistic spirit abroad with regard to the future. It is quite certain that money never commanded such value—not even in pre-war days—and the prices now ruling in the industry demonstrate that no effort has been spared to give the public all the advantages which it has been possible to effect by improved methods of manufacture. As an instance of this, mention can be made of a thoroughly well-built six-cylinder 17.8 horse-power car with a cabriolet body at £575. There is indeed quite a boom in "all-weather" bodies. In the shortest possible time, open touring cars can now be converted into comfortable weather-proof carriages, with self-starters and electric lighting thrown in. Finality in design has apparently not been reached with regard to motive mechanism, and although overhead valves to the engines have come more to the fore than previously, the poppet valve still predominates. So, too, does water cooling, with its attendant radiator and circulating devices. Opinion is still divided between pump and thermo-syphon systems, and although the pump introduces what is sometimes a source of minor troubles through leaky glands, &c., there is no doubt that by passing the water more quickly through the water jacket, the heat generated is more quickly dissipated than is the case with the thermo-syphon. With reference to gear boxes and transmission, apart from an attempt to introduce the friction drive, the three-speed gear-box still predominates. Some manufacturers favour the central gate change, but the gear lever on the right-hand side has still many adherents, especially in the higher-powered cars. For final transmission purposes, the spiral bevel gear is becoming more popular, and rightly so; in fact, the old straight bevel is now nearly a thing of the past. The spiral bevel gives much of the quietness associated with the worm, and is livelier at starting, but there are many firms which retain worm gear, the life of which, when looked after, is surprising. In fact, the life of a well-designed worm drive, if properly lubricated, seems to be quite equal to that of the engine.

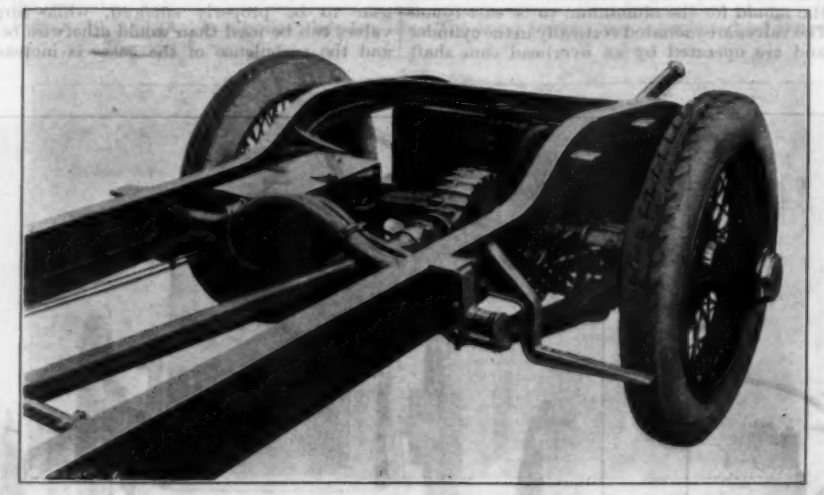


FIG. 4—REAR AXLE OF 20-H.P., ROLLS ROYCE CHASSIS

All-round braking of the road wheels has made some small headway since last year, but motorists in these islands have not yet found any decided need for additional retarding power. Brakes on front wheels involve somewhat complicated mechanism, which is more or less exposed to mud and dust, and which, if not carefully adjusted, is liable to be an element of danger rather than giving increased safety. In any case, we can see no tangible reason for fitting a four-wheel braking system on light cars. In the not far distant future, when the new arterial roads have been constructed to facilitate higher speeds, there may arise a need for better braking systems for the high-power cars, and then the four-wheel brakes will come into their own.

At a time when the chief consideration of designers is to cheapen production, it is scarcely likely that new methods of springing can receive adequate attention. Motor owners who require something more delicate than the present leaf spring have therefore to content themselves with one of the many different shock absorbers that are on the market. These, however, can only be regarded in the light of temporary expedients, and when some satisfactory system of hydraulic suspension makes its appearance, accessories of this kind will no longer be required.

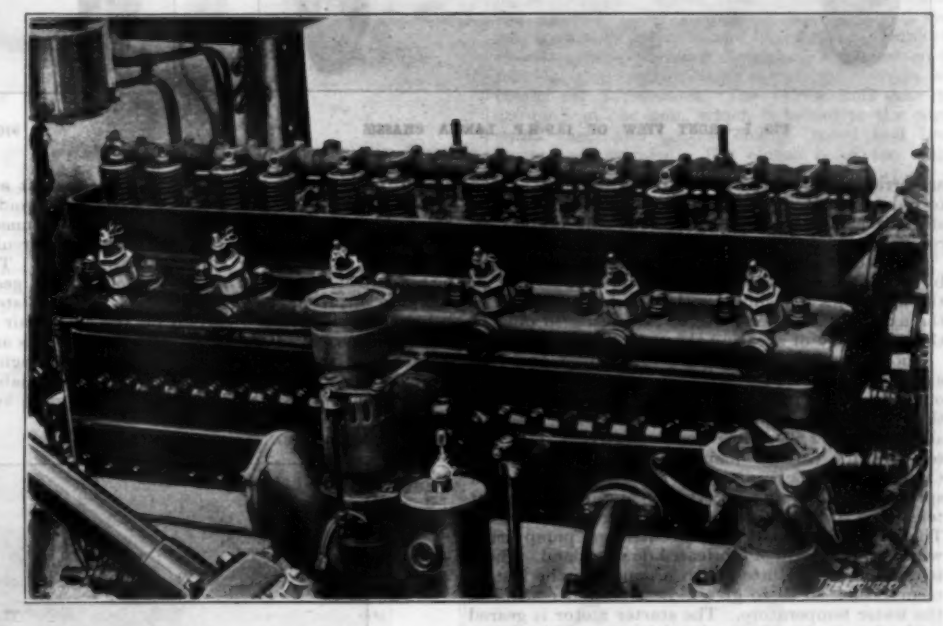


FIG. 6—20-H.P. ROLLS ROYCE ENGINE

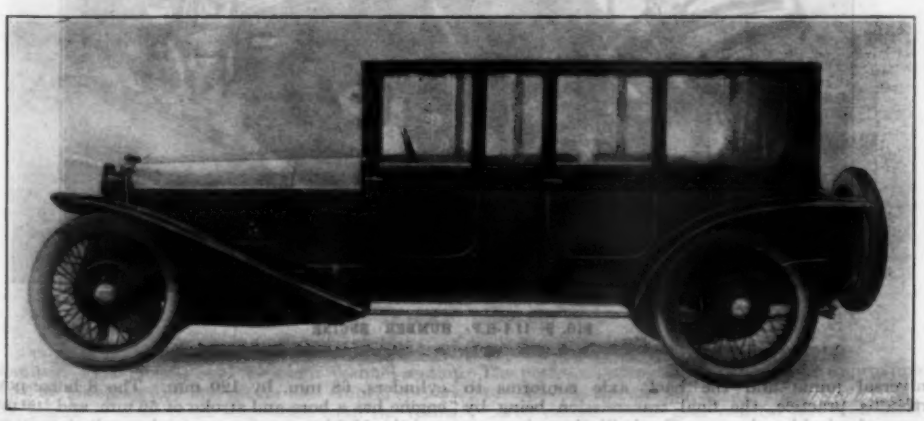


FIG. 5—13.9-H.P. LANCIA SALOON CAR

ROLLS-ROYCE.

Hitherto, the six-cylinder engine has been associated almost exclusively with cars of high power. It is now coming into vogue on cars of quite small power, thanks to improved methods of manufacture. We are nearer now than during the last seven years to the dawn of cheap motor travel. The reduction in the price of tires, coupled with their better manufacture, cheaper petrol and improved roads, all tend to bring the motor car within the means of a section of the public to which motor owning has hitherto been a dream. Although it is not on view at Olympia, the new 20 horse-power Rolls-Royce car, which we had an opportunity of inspecting at the company's show-room in Conduit-street, is a decided step towards popularising this firm's hitherto exclusive motor carriage. Details of this new car are given in Fig. 14, page 498, and Figs. 4 and 6. The engine is of the six-cylinder variety, with cylinders 3in. by 4½in. and is rated at 21.6 horse-power. It is of unit construction, with gear-box, three-point suspension, monobloc, with detachable cylinder head, overhead valves, battery ignition and forced lubrication. The clutch is of the single dry plate kind, and the three-speed gear-box has a central change lever. The final transmission is of the spiral bevel variety, and the road springs are semi-elliptic. The engine crank shaft is carried in seven bearings and runs at 150 to 3000 r.p.m.

The cylinder arrangement is noteworthy, as the pushrods for the overhead valves are on the opposite side to the ignition plugs, which latter are in an accessible position, *i.e.*, they are well in the crown of the combustion chamber, out of the way of oil. The valve gear, it is claimed, is particularly silent and remains so, owing to the great care taken in the design and proportions of the valve-operating mechanism. All the valve seats are water cooled. The half-time wheels driving the cam shaft and other units are helically cut, and the damped spring drive is used to give a smooth and silent drive through the full range of speed. The pistons are of aluminium, and owing to the careful arrangement of piston rings the wearing surface can be well lubricated without fear of excess of oil entering the combustion chamber. The pressure lubrication, it may be noted, is also carried to the little ends of the connecting-rods, which are extremely light nickel steel forgings. The clutch, which is of the single dry-plate type, is fitted with Ferodo and steel surfaces. It carries four levers revolving with it, so that the thrust is light, and, with this and other features, its operation is remarkably smooth. Owing to the extreme lightness of the driving member, and its great freedom when declutched, the changing of gears is stated to be extremely easy, certain and free from shocks.

The gear-box, which provides three forward speeds and a reverse, is of the conventional sliding type. The side shaft is driven by helical gears and has the unusual feature of being supported in three bearings. Enclosed in the gear-box there is a special worm drive for the speed indicator.

The back axle is of very light construction, having aluminium central box, steel tubes with large flanges and a substantial tie-rod. It is remarkably compact

* No. I. appeared November 3rd.

for the diameter of the bevel gear. The road wheels are mounted on extensions of the tubes, so that no part of the rear axle is subject to stresses due to the weight carried, the internal driving shafts being subject to torsional stresses only. The bevel gears are spirally cut, and the pinion is fitted with a third (nose) bearing, so that its alignment may be maintained.

The front axle is a high tensile alloy steel forging of I section. It is of light proportions, as are also the stub axles, which are of large diameter, radiused and bored for strength and lightness. The steering pivots are arranged to give "centre point steering," so as to reduce to a minimum the forces exerted upon the steering gear through rough roads, soft borders to roads or deflated tires.

The attachment of the road springs is carried out by the use of a steel sheath which fits keys formed on the axle, thus transmitting the shocks directly from the axle to the upper plate of the spring to obviate the possibility of shearing the central bolt.

Shock dampers are fitted to both front and rear axles. They are of special construction, and the back ones are of the progressive type. The radiator is of the honeycomb type, and is fitted with a set of shutters, under the driver's control, so that the water temperature can be maintained in cold weather. Close behind the radiator a fan is mounted on a spring-controlled support, which maintains a constant tension in the vee belt over a large range of movement. The water is circulated by a centrifugal pump fitted with a special form of lubricated double gland. There is a thermometer fitted with a gauge on the instrument board, so as to give indication and control of the water temperature. The starter motor is geared to the fly-wheel, with a spring drive automatic pinion. There is an extra nose bearing on the motor spindle to prevent excessive deflection and risk of breakage. It is controlled by a pedal-operated switch which has the unusual feature of being oil immersed.

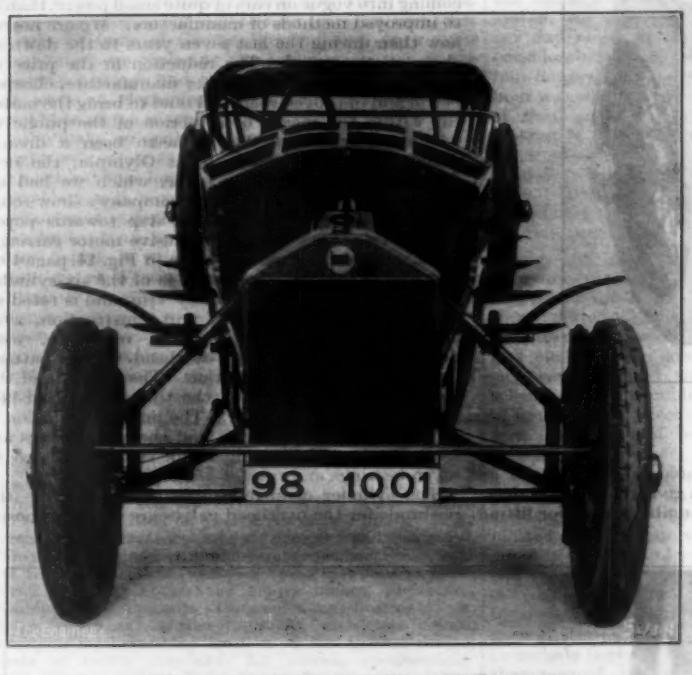


FIG. 7—FRONT VIEW OF 13.9-H.P. LANCIA CHASSIS

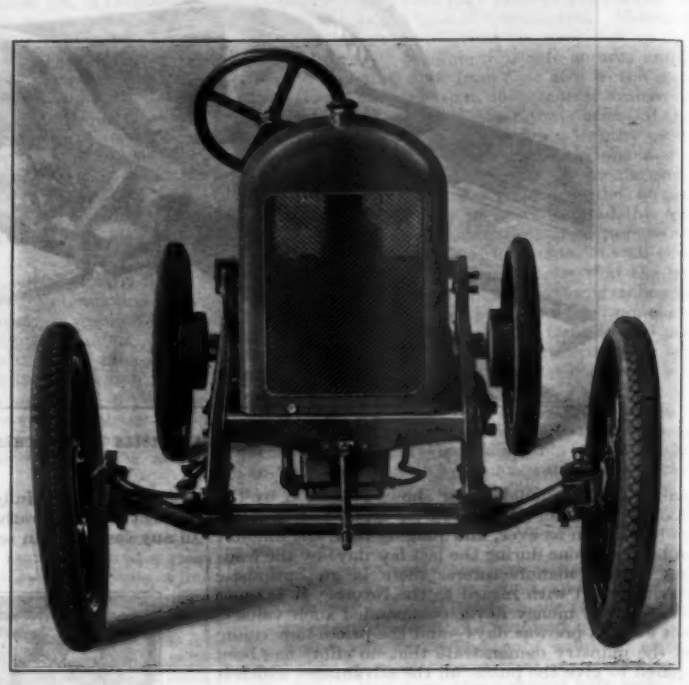


FIG. 8—FRONT VIEW OF GWYNNE CHASSIS

LANCIA.

From an engineering point of view, the Lancia Company's exhibits have a special interest, owing to the method of construction of the frame of the front suspension system. The frame and foundation of the body are built up as a single unit, with a resultant saving in weight which is very remarkable. Fig. 5 represents the complete car with saloon body; Fig. 15 on page 498 a view of the frame; and Fig. 7 is a front view of the chassis showing the front axle and suspension. The carcase is built up of light steel pressings about ¼in. thick, riveted and welded together. There is a central tunnel for the propeller shaft, and a transverse tunnel for the rear axle, by which means the centre of gravity of the car is kept much lower than usual. The longitudinal central tunnel which divides the lower part of the body serves to strengthen the whole. The body is completed by aluminium and sheet steel panelling. In the front suspension the axle, as usually understood, is dispensed with, and a triangular tubular framework is made use of, as shown in the illustration. There are no front springs, the necessary flexibility being obtained by means of shock absorbers composed of coiled springs and hydraulic dashpots in an oil-tight casing. Front wheel brakes are fitted, the drums of which are inside the road wheels, the centre of the brake band being less than ¼in. out of the centre of a vertical line passing through the tire. A foot pedal operates all four brakes. The engine is of the four-cylinder vertical V type, with overhead valves, the cylinders being set at an angle of 20 deg. It is rated at 13.9 horse-power, and has a cubic capacity of a little over 2 litres. The bore and stroke are 75 mm. by 120 mm., from which the makers claim to obtain 45 maximum horse-power. The engine has cast iron cylinders, around which the aluminium jacket and crank case are cast. The cylinders are cast with a flange on the upper end of the barrel and are roughly machined before being set in the mould for the aluminium to be cast round them. The valves are mounted vertically in the cylinder head, and are operated by an overhead cam shaft which receives its motion from a vertical shaft and helical gears. Forked connecting-rods are avoided by staggering the opposing cylinders. The connecting-rods are tubular, and the crank shaft has circular webs. It is carried in three plain bearings. The pistons are of aluminium alloy. The clutch and gear-box are in front of the dashboard. Immediately behind the engine, and carried on the same pair of tubes is a very small gear-box, with three speeds and a reverse. Although not of the same unit as the engine, the whole is bolted together and easily detachable. The propeller shaft is of the open type, with two universal joints and the back axle conforms to orthodox practice, the final transmission being by means of spiral bevel gears. Semi-elliptic springs are used. The four-passenger body has a 10ft. 3in. wheel base and 4ft. 4½in. track, the total weight with radiator and tanks filled being only 18½ cwt.

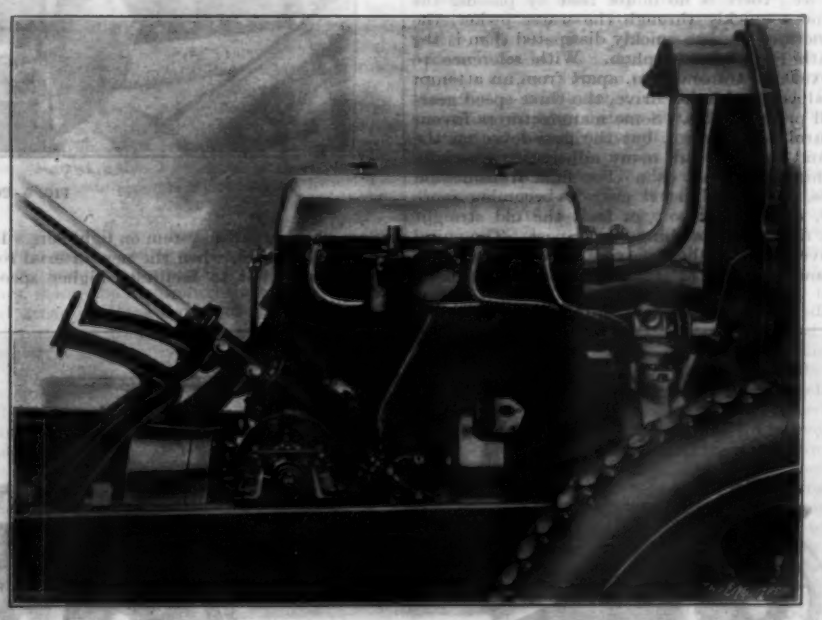


FIG. 9—11.4-H.P. HUMBER ENGINE

HUMBER.

The Humber Company's programme for 1923 comprises three cars, namely, a 15.9 horse-power, an 11.4 horse-power, and an 8 horse-power model. The 15.9 horse-power chassis, is illustrated in Fig. 16, page 498, while Fig. 9 and Fig. 17 relate to the 11.4 horse-power car. All the cars will be fitted with a new type of engine, in which the induction valves only are placed in the detachable cylinder heads, while the exhaust valves are situated in pockets in the cylinder casting. The makers claim that this system of manufacture enables the valve gear to be properly silenced, while larger sized valves can be used than would otherwise be possible, and the turbulence of the gases is increased. The overhead valves are operated from the camshaft on the near side of the engine through adjustable tappets, push rods, and rocker arms, a collar being fitted on the lower ends of the push rods to accommodate a spring. The valves themselves are also fitted with springs. In this way it is claimed that the load is equally divided between the valve and push rod. The rockers are supported on four independent posts, and lubrication is well provided for. Ports are provided between the crank case and the enclosed push rod chamber, so that all tappets are lubricated by oil mist. The 11.4 horse-power engine has four cylinders, 68 mm. by 120 mm. The 8 horse-power engine has a bore and stroke of 56 mm. and 100 mm., and the 15.9 horse-power engine has cylinders 80 mm. by 140 mm. All the engines have four cylinders. The Humber Company still adheres to the cone clutch with Ferodo facing, and four forward speeds are provided in the larger cars, while the 8 horse-power car has three speeds. Ignition is by high tension magneto. Thermo syphon cooling is fitted on the smaller cars, and pump circulation on the 15.9. The petrol is supplied to the engines of the larger

cars on the Autovac system, but on the 8 horse-power car gravity feed prevails. Spiral bevel gearing is fitted to the live axle.

GWYNNES.

In order to meet the current demand for a really inexpensive British-built light car Gwynnes Engineering Company, Limited, Hammersmith, is putting on the market an 8 horse-power car of remarkable value—Figs. 8, 10, and 18. It is built either as a two

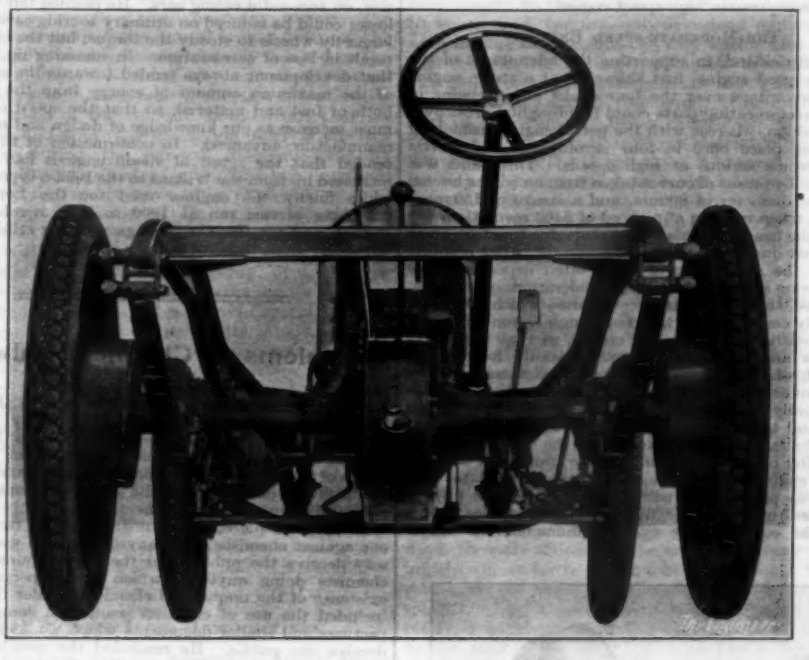


FIG. 10—REAR VIEW OF GWYNNE CHASSIS

or three-seater. The engine has four vertical cylinders with a bore of 55 mm. and a stroke of 100 mm. It is fitted with a three-bearing crank shaft and with overhead push rod operated valves. The ignition is by magneto, and the carburetter is a Claudel-Hobson. Aluminium pistons are used. The lubrication is on the pressure system. A special feature of the motor is the manner in which the mixture is warmed before passing to the combustion chamber. The chassis is of the plain channel section type, and is slung fore and aft on half elliptic springs. The engine is three-point suspended from the frame. The front axle is also of channel section, and is furnished with forged fork ends.

The steering is by worm and sector. The back axle comprises a final bevel drive and a differential, which is of the semi-floating type. Both sets of brakes apply direct to the rear wheel hub drums, and in each case adjustment is readily carried out. The wheel base is 7ft. 3in., and the track 3ft. 6in. The wheels are fitted with 700 mm. by 80 mm. covers. The clutch is of the internal leather cone type, and the clutch withdrawal bearing is fitted with a simple means of lubrication. Flexible joints are provided between the clutch and the gear-box, the latter being controlled by a central gate lever. Three forward speeds are provided, the ratios being as follows—4.83, 9.2, and 14.25 to 1. The reverse ratio is the same as that of the bottom gear. The hand brake lever is mounted by the side of the gear change lever. The equipment of the Gwynne "Eight" consists of a standard three-seater clover leaf body, fitted with a hood which protects all three passengers, and a single wind screen. The electric lighting set consists of a dynamo driven from the engine and three lamps. Two of the latter are mounted on the front wings, and are controlled by a dimming switch. The weight of the chassis is 12 cwt., the weight of the car complete being 14 cwt. The petrol consumption is stated to be approximately 40 miles to the gallon.

The design of the gear control has been carefully studied with regard to the driver's convenience in gear changing. The casing of the gear-box is integral with the propeller shaft casing, and has a large lid for inspection purposes. On its near side it carries an extension terminating in a ball which is housed in a split socket bolted to the main cross member of the frame. The function of this spherical joint is to transmit all torque and driving stresses from the back axle. The latter is of the semi-floating type, and is of robust construction, though light in weight. The ends of the axle sleeves are trussed to the forward end of the propeller shaft casing.

Special attention is drawn to the fact that a differential is fitted. Since the torque and driving stresses are sustained by the axle and propeller shaft casings, the rear springs are relieved of any function beyond that of suspension.

This car, together with the 11.9 Albert and the 14 horse-power Gwynne Albert cars are being placed on the market by the Service Motor Company, Limited, Great Portland-street, London, W.1.

CROSSLEY.

Figs. 11, 12, and 13, and Fig. 19, page 498, show details of a new model which has recently been evolved by Crossley Motors, Limited, Manchester, to meet the requirements of the ever-increasing section of motor car users which requires an economical and well-designed vehicle of moderate price. The 12-14 horse-power car possesses many of the features incorporated in the larger cars made by this firm. Not the least important feature of this new production is the roomy body which provides ample accommodation for four passengers. The engine has four cylinders cast monobloc, with side-by-side valves, and a bore and stroke of 85 mm. and 120 mm. It is rated at 15.6 horse-power. The engine has a three bearing crank shaft automatically lubricated by means of an oil pump. The cam shaft has also three bearings, and the cams are solid with the shaft. The lubrication, which is automatic, is effected by an oil pump which delivers the lubricant to troughs, in which the connecting-rod ends dip. The big ends of the connecting-rods are drilled and have guide webs to gather the correct supply of oil from the troughs. Oil galleries are also arranged over each main bearing for the crank shaft. A large oil filler is fitted on the near side of the engine.

Thermo syphon cooling with an adjustably driven fan maintain the engine at the required temperature. The starting motor is spigoted into the crank case, and transmits power to the fly-wheel by means of a Bendix pinion, and the dynamo is mounted on the front of the engine. It is driven by a chain with means for adjustment. The clutch and gear box are built in one unit, which is bolted to the engine crank case, and central change-speed and brake levers are provided. The clutch is of the single-plate variety with fabric friction discs, which are easily adjustable. The spring pressure is self-contained, and there is a ball thrust for withdrawal. The spigot is fitted with a ball bearing. The clutch is easily adjusted through an accessibly placed inspection door. The steering is of the worm and wheel, type, there being a simple adjustment for both worm and wheel. The steering gear is entirely enclosed and the side steering tube is fitted with spring buffers. The gear box is an aluminium casting. There are three forward speeds and a reverse. The gear ratios are: 1st, 12.5 to 1; 2nd, 7 to 1; 3rd, 4 to 1; and the reverse, 20.94 to 1.

For ignition purposes a high-tension magneto driven by a flexible coupling from the rear end of the dynamo is fitted, and provision is made on the bracket for easy adjustment of the magneto to maintain accurate alignment with the dynamo. The rear axle is of the semi-floating kind, with spiral bevel

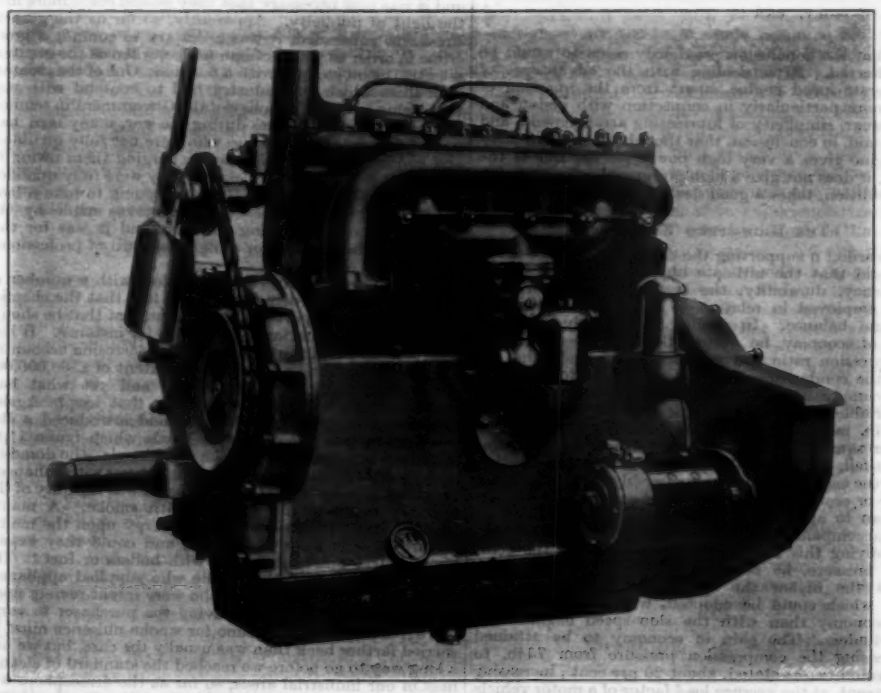


FIG. 11—12-14-H.P. CROSSLEY ENGINE

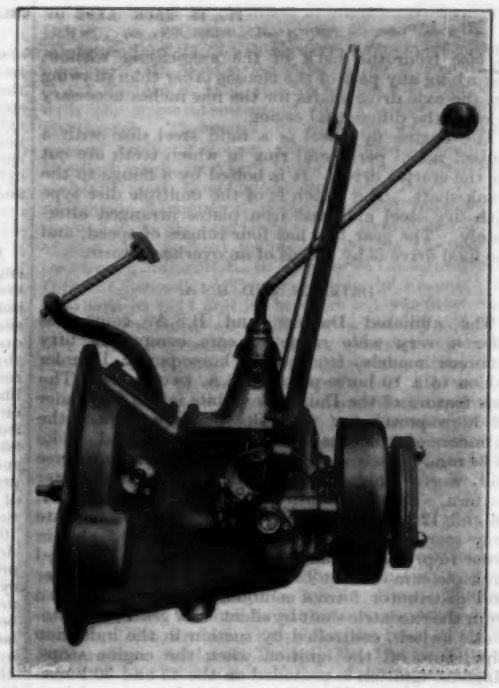


FIG. 12—GEAR BOX OF CROSSLEY ENGINE

drive. Special provision is made in the pressed centre piece for inspection of the differential and final drive gears. The universal joints are of fabric of ample proportions, and the speedometer is driven by worm gearing at the rear of the gear box. An accelerator pedal is fitted between the clutch and brake pedals, and there is hand control both for ignition and throttle on the steering column. Although fairly easy of access, this method of control is neither so handy nor so delicate as the lever and sector system on the steering wheel. The petrol is supplied to the engine by gravity from a tank under the bonnet. The tank has a capacity of 8 gallons. The main frame is sufficiently strong, and is made up of deep channel section steel with wide flanges. There are three channel cross members, and an angle cross member at the rear. The springs are half elliptic and offset. They are directly under the side members of the frame, and the rear springs are undershung.

"H. E."

One of the cars on view at the White City Show, which makes a very good impression on an engineer, is the "H. E." car, which is made by the Herbert Engineering Company, Limited, Caversham, Reading. It is a moderately priced vehicle built on sound lines. The engine is of the four-cylinder class, with side-by-side valves of large area. It has a detachable cylinder head with non-ferrous caps giving independent access to the valves, so that they can be lifted out without disturbing the head or jointing. The cam shaft and associated drives are by inverted tooth chains with independently adjustable double excentric mounting of the mid sprocket wheel, combined with means for ensuring true linear relationship of the dynamo drive with provision for adjusting its chain or the magneto chain independently. The differential worm axle gear unit may be removed

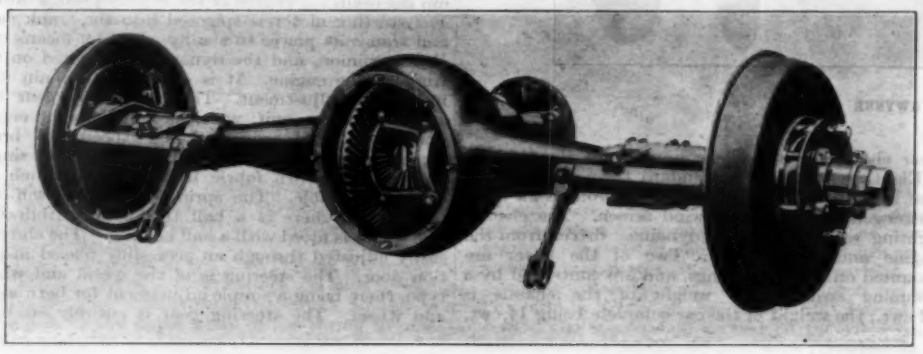


FIG. 13—BACK AXLE OF CROSSLEY 12-14-H.P. CAR

en bloc from the back of the axle-casing without disturbing any part of the chassis other than drawing out the axle drive-shafts for the few inches necessary to clear the differential casing.

The engine fly-wheel is a mild steel disc with a central raised peripheral ring in which teeth are cut for the starter drive. It is bolted by a flange to the crank shaft. The clutch is of the multiple disc type with dry steel and cast iron plates arranged alternately. The gear box has four ranges of speed, and the final drive is by means of an overhead worm.

DAIMLER AND B.S.A.

The affiliated Daimler and B.S.A. companies offer a very wide range of cars, comprising fifty different models, from a 45 horse-power Daimler saloon to a 10 horse-power B.S.A. two-seater. The new feature of the Daimler exhibits is the 6-cylinder 12 horse-power car with sleeve valve engine, the cylinders of which have a bore of 59 mm. and stroke of 94 mm. These cars have four speeds and a reverse and worm final transmission of the Lanchester pattern. Battery ignition is provided on the 21, 16 and 12 horse-power engines in order to facilitate easy starting and slow speed running, and also in order to promote quietness by the use of a slow speed multiple cam contact breaker. The contact breaker and distributor form a combined unit that is driven from the excentric shaft by silent skew gear. An automatic switch, controlled by suction in the induction pipe, cuts off the ignition when the engine stops. Magneto ignition is provided on the 45 and 30 horse-power engines. The magneto is skew gear-driven from the excentric shaft.

SUNBEAM.

The Sunbeam Company exhibits at Olympia three types of chassis, viz. :—A medium powered 4-cylinder model of 14 horse-power nominal rating, whose engine is capable of developing over 30 brake horse-power; a larger 4-cylinder model, with an engine nominally of 16 horse-power, but developing over 40 horse-power on the brake, and a 6-cylinder model of similar design, rated at 24 horse-power, but the engine of which actually gives, it is said, well over 60 horse-power at the maximum number of crank shaft revolutions. All these chassis are fitted with overhead type valve engines.

High-Compression High Speed v. Low-Compression Moderate Speed.*

At the meeting of the Institution of Automobile Engineers which took place on the 8th inst., a debate on "The High-compression High-speed Engine *v.* the Low-compression Moderate-speed Engine for General Use in Motor Vehicles" was arranged, the claims of the low-compression moderate-speed engine being presented by Major F. Strickland, whilst Mr. H. R. Ricardo spoke in favour of the high-compression high-speed engine.

THE MODERATE-SPEED ENGINE.

Major Strickland, in supporting the advantages of the moderate-speed engine, first showed that a steam engine had an advantage over the four-stroke petrol engine in that the reciprocating parts could be brought to rest by a steam cushion, whereas with the petrol engine cushioning only takes place once in four revolutions, and inertia forces become serious at high speeds. This point was illustrated by means of curves taken from an engine having a cylinder diameter of 80 mm. and a stroke of 150 mm., in which, when running at a speed of 3400 revolutions per minute, the bending stress of the shaft due to intertia was double that due to the explosion pressure. After pointing out that the actual size of parts often depended more upon bearing surface than upon considerations of strength, he showed that the bearing pressures, which remained practically constant with the steam engine, would increase very seriously with the petrol engine, so that the size of the parts and therefore the weight would have to be increased, which appeared to indicate that there would be some point at which the weight of the engine would increase more rapidly than the horse-power. In developing this theme, and taking into consideration the stresses on the big-end bolts, the bending forces on the crank shaft and the bearing pressures, he came to the conclusion that the lightest engine could be made at about 1200 to 1500 revolutions per minute, with a cylinder of from 92 mm. to 103 mm. in diameter. With regard to engines having the stroke equal to the cylinder diameter, the curves showed that the conclusion previously come to would be hardly affected. After dealing with the advantages of the moderate-speed engine, apart from the question of weight, more particularly in connection with piston and cylinder wear, simplicity of lubricating arrangements and noise, he said, in conclusion, that though the modern high-speed engine gives a very high power for the size of the cylinders, it does not give a high power per unit of weight, and, in addition, takes a good deal of keeping in order.

THE HIGH-SPEED ENGINE.

Mr. Ricardo, in supporting the claims of the high-speed engine, said that the ultimate objectives in any design are efficiency, durability, the best possible use of the material employed in relation to weight and cost, and silence and balance. In dealing particularly with the question of economy, he stated that it depended upon the compression ratio and mechanical efficiency and the form of the combustion chamber. In order to show the limiting compression ratio he described some tests made on a variable-compression engine which indicated that from 60 lb. per square inch compression pressure up to 95 lb. per square inch, the power rose and the fuel consumption fell, while at 97 lb. per square inch compression pressure the engine began running harshly with no increase of power or economy. At 100 lb. per square inch detonation began to appear, and this became very definite at 102 lb., accompanied by a drop in power and economy. Accompanying this warning against overdoing the compression pressure, he pointed out that the smaller the cylinders the higher the speed and the compression pressure which could be adopted, which would lead to better economy than with the slow-speed engine with large cylinders. The gain in economy to be attained by increasing the compression pressure from 75 lb. to 110 lb. would be, he stated, about 20 per cent., increasing to 35 per cent. at the average load factor of a motor vehicle engine. Dealing with the heat flow, which, he said, increased very rapidly as the compression pressure approached 100 lb. per square inch, he pointed out that this led not only to trouble with the sparking plugs, valves, piston rings, &c., but to detonation, and that when this once appeared the high-compression engine would lose all its advantages. In dealing with the question of high speed, he made the assumption that such an engine must last as long as the low-speed engine or show some compensating advantage. The high compression pressure giving a higher mean pressure would allow the use of smaller cylinders and therefore smaller and lighter pistons, which, owing to the reduced heat flow, would run cooler and therefore allow the lubrication to be more efficient and so reduce the wear; this for equal rates of wear would allow a higher road factor, while the smaller and thinner piston would reduce the inertia forces down to little more than those of the low-speed engine of the same horse-power.

Mr. Ricardo then made the statement that if the parts were carefully designed, and if the gases, after passing the valves, had a free entry into the cylinder, large and heavy valves were not necessary for high-speed engines. After a brief discussion of the causes of vibration in a four-cylinder engine, he then went on to deal with the "rolling losses," which were particularly noticeable in racing cars, due to hysteresis losses in the tires, necessitating the introduction of eight-cylinder engines, even of the smallest size, on successful racing cars. He pointed out that these losses could be reduced on ordinary touring cars by fitting larger fly-wheels to steady the torque, but that this would result in loss of acceleration. In summing up, he stated that development always tended towards the attainment of the maximum amount of energy from the minimum both of fuel and material, so that the speed of rotation must increase as our knowledge of design and methods of manufacture advanced. In confirmation of this he contended that the speed of steam engines had gradually increased up from the Willans to the Belliss type of engine, while finally the engines used for the London-Paris aeroplane service ran at 1900 to 2000 revolutions per minute, and yet these engines gave better reliability and durability than those of a lower speed.

* Extracts from a debate before the Institution of Automobile Engineers.

Problems in Chemical Industry.

At the opening meeting of the session of the London Section of the Society of Chemical Industry, Dr. E. F. Armstrong, F.R.S., the President, gave a lecture on "Some Problems in Chemical Industry," in which the status of the chemist and the need for co-operation between chemists and engineers was the principal theme, although several other matters were mentioned.

In the first place, Dr. Armstrong made two protests, one against chemists doing anything which would in any way deceive the public, and the other against qualified chemists doing anything which would perpetuate the existence of the unqualified chemist. Under the first, he included the use of chemists' names on company prospectuses and similar documents which would in any way deceive the public. He reminded the members of the industry that the public were their final judges, and if chemists were to secure that position in the deliberations of the nation to which they were entitled they must act honestly by the public. There must also be the highest possible standard of professional etiquette and conduct, combination among themselves and clear thinking and expression. He wished to see the status of the chemist placed on the highest possible plane, and during the year of his office he would take every opportunity of preaching that doctrine. He wished to put it very definitely that the nation had in its chemists a body of men in whose hands perhaps to a large extent a great deal of the future of civilisation would rest. He had said once or twice, and notably at the annual dinner, that chemists had been too modest. They seemed to have developed into thoughtful men in contradistinction, might he say, to the politician, and it was now necessary that they should come more into the light of publicity. Apparently, so far as the general Press was concerned, it was necessary to commit a great crime in order to get a column notice, whereas the greatest scientific event escaped with a few lines. One of the greatest difficulties which the industry had to contend with was that owing to the false policy of the Government in sending chemists into the trenches during the war, many men had to be taken into the factories who were not fully qualified, and employers who were now discharging them owing to the slump did so in the belief that they were fully qualified and representative chemists. It was going to take a long time to live down some of the mistakes made by the chemical fraternity during the war, and it was for this reason that he pleaded for a high standard of professional conduct and attainment.

Dr. Armstrong then went on to deal with a number of matters in order to demonstrate the fact that the chemist had not taken the part in affairs in the past that he should have done. The matter of corrosion, for instance. It had been said by Sir Robert Hadfield that corrosion accounted for damage to iron and steel to the extent of £500,000,000 per annum throughout the world, and yet what had chemists done to prevent or modify that loss? Again, smoke abatement. Lord Newton had introduced a Bill last session into the House of Lords which ignored the cause of four-fifths of the smoke trouble, viz., the domestic grate, but threatened the poor manufacturer with enhanced penalties. He was not at all sure that it was the duty of the ordinary manufacturer to deal with smoke. A manufacturer spent all his capital and energy upon the manufacture of, say, soap or biscuits, and could they expect him to carry out experiments with boilers or fuel? The fault really lay with the people who supplied appliances for dealing with smoke, and who were intent merely upon selling the apparatus and leaving the purchaser to carry out experiments. The blame for smoke nuisance must be carried farther back than was usually the case, but we had a long way to go before we reached the standard of cleanliness in our industrial areas, so far as the atmosphere was concerned, that had been reached on the Continent and in New York. Here was a field for the chemist and engineer to work in co-operation.

After a complimentary reference to the work of the Fuel Research Board and a complaint that there should be so many individual societies formed in the chemical industry, Dr. Armstrong gave some account of experiments carried out by his firm as regards water softening, which were based on the extraordinary power of zealite, both artificial and natural, to exchange bases. The result had been a substance which was about four times as active as similar materials produced by what he termed "rougher methods." He mentioned these experiments, he said, in order to show the absolute necessity for clear thinking, on the one hand, and to demonstrate how much, when the chemical nature of the reaction was examined, depended upon the preservation of surface.

A Seven-Day Journal.

The New Battleships.

Although the Admiralty has definitely invited tenders for the construction of the two new battleships sanctioned under the Washington Conference agreement, a rumour gained currency towards the end of last week that the actual laying down of the vessels would probably be considerably delayed on the score of economy. The Admiralty accordingly issued a statement which, although it did not categorically deny the truth of the rumour, pointed out that, as Parliament had approved the laying down of the two battleships during the current financial year by passing the Navy Estimates for 1922–23, any deviation from that policy would have to be explained to, and sanctioned by, Parliament. Under the Washington agreement, it may be pointed out, there is a limit to the time within which the ships permitted may be constructed, the object sought being, of course, to prevent any nation by unduly postponing its building programme from getting advantage of recent modern developments at the expense of its rivals. Meanwhile considerable discontent is being manifested at Portsmouth at the failure of the Admiralty to apportion any of the new work to the dockyard towns, on the ground that to do so would involve considerable expense in altering the slipways to suit the building of the warships. It is alleged that, according to the naval returns, the Government has given large sums to private shipbuilding firms for the purpose of reconditioning their slips. Joint action with the other dockyard towns is being urged, for it is claimed that the Admiralty should see to it that the national yards are placed in a state of efficiency before it subsidises private firms.

Black Smoke from Locomotives.

A short time ago—see the Journal for August 4th—the London and Brighton and the South-Eastern Railways were summonsed at the instance of the London County Council for permitting the emission of black smoke from certain of their locomotives. The summonses were dismissed and the companies granted costs, for the magistrate held that it was not practicable to construct an engine which would, as required by a section of the Railway Act, entirely consume its own smoke. The London and North-Western Railway was less successful on Monday, when it was summonsed at the Eccles Borough Police Court for creating a nuisance by permitting certain engines to emit black smoke outside the Patricroft locomotive sheds. On behalf of the railway company it was contended that it was not possible to construct an engine which, even when running at top speed, would not emit smoke. It was admitted that in the instance complained of better stoking would have reduced the quantity of smoke. In the end the case went against the company, and a fine of four guineas was inflicted upon it. It would be interesting to know what the law exactly understands by the words "constructed to consume its own smoke," and to what extent this requirement of the Railway Act is consciously taken into account when a new engine is being designed.

A Peculiar Gas Tragedy.

Attention should, we think, be paid by gas authorities, local surveyors and others to the circumstance in which two people lost their lives and four were poisoned—happily, not fatally—at Stafford on Monday as a result of an escape of gas from a main in the street. It is believed that the main was fractured by the passage over it of a heavy vehicle, and that the escaping gas confined to the sandy subsoil by the tarmacadam road surface found its way into the adjoining cottages. A smell of gas was noticed in the houses on Sunday and the supply to them was cut off, but obviously in the circumstances the precaution would be ineffective. We do not know whether the houses affected had the now usual layer of concrete beneath the floors, but even though they had the minimum 6in. raft it is very doubtful whether the concrete as laid by the average builder of houses would be gas-tight. In any event the remedy should be sought, not in making houses impervious to a subsoil leak of gas, but in so disposing and constructing the main in the street as to be secure against fracture. It need hardly be pointed out that the increasing weight of road vehicles must bring such fracture within the bounds of possibility in many districts in which the mains were laid before such increase was anticipated.

Tramways in the City of London.

Ever since the London County Council began running its tramways it has been endeavouring to extend its system within the limits of the City of London, but it has uniformly been faced with the strong and so far successful opposition of the City Corporation. It is once again trying to secure powers for this purpose, the precise schemes in view being first, the running of tramways from the present "dead end" in Gray's Inn-road down Holborn and Farringdon-street to a new dead end at Ludgate-circus; and secondly, across the recently reconstructed Southwark Bridge to a dead end in Upper Thames-street. The City Corporation's consent has been sought to these schemes, but is not at all likely to be secured, for not only are dead ends regarded with intense dislike, but the City authorities consider that the schemes proposed are but the first instalments of a more complete invasion of the City's already congested streets, and in particular would eventually lead to the tramway being carried across Ludgate-circus, a point already severely restrictive to the free flow of traffic. The Corporation, moreover, holds that the day of the tramway, so far at least as London is concerned, is passed, and that nothing is to be gained by permitting extensions within the City's boundaries, which could not with less disturbance be secured by means of the motor omnibus.

The Capsizing of a Brazilian Steamer.

On June 16th, when the Brazilian Lloyd steamer Avare was being towed out of dock at Hamburg, she developed a list to port, and then, when tugs endeavoured to right her, suddenly to starboard, with the result, as we recorded at the time, that she capsized. In doing so she carried to their deaths twenty-six members of the crew and thirteen workmen, who were on board her at the time. The supposition that the vessel was undocked without sufficient ballast is borne out by the findings of the Hamburg Assize Court, which, after an inquiry extending over four days, recently sentenced the captain to nine months' imprisonment for negligence in being absent from his post when the vessel was being undocked and in failing to forbid the movement of the ship until he had received a report from the chief engineer that the ballast tanks were filled. The captain's deputy, the chief engineer and the pilot were acquitted, although it was not established by whom the order to start the undocking operations was given. It would appear that the captain's deputy informed the pilot that the tanks would be filled in about forty minutes, and that at the end of that time steps were taken to undock the vessel, whereas the filling of the tanks would really have occupied from four to six hours.

The Value of Railway Statistics.

In the course of a paper read before the Institute of Transport on Monday night, Sir William Acworth dealt with the criticism levelled against the railway operating statistics compiled by the Ministry of Transport. It had been said, he remarked, that these statistics had not in a single instance resulted in a practical economy being effected. His reply to such criticism was that a fever could not be cured by the use of a clinical thermometer. He did not know what it cost to compile the new statistics, but even although it amounted to half a million pounds, the expenditure on them would still only represent a quarter of one per cent. of the operating expenses of the railway companies last year. As showing the value of the statistics he remarked that experienced railwaymen used to estimate the average length of haul in this country at from 35 to 50 miles. No one thought it was so high as 58 miles, the actual figure revealed by the statistics. The average freight train load was not 200 to 220 tons, as had been supposed, but 135 tons. It had been argued that British goods trains had to be light because they ran at high speeds. Actually the average freight train speed during the first six months of this year was only 11.7 miles an hour. It was argued, too, that small trucks were necessary because the present ratio of load to capacity could not be maintained if larger wagons were employed. In actual fact the average capacity of British goods wagons was 10.24 tons, while the average load was only half that amount. The new statistics made the broad facts of railway operation available for the first time, but their interpretation required expert knowledge. It was the duty of the railways and to their own interest to enlighten the public as to their meaning.

Breaking Up Warships.

At the present moment there are still about 120 war vessels in the ports of this country awaiting the shipbreaker's attention. In this connection it is just possible that some of the work may be conducted at Belfast for the first time in its history. The well-known firm of shipbreakers, &c., T. W. Ward, Limited, of Sheffield, has arranged, we understand, to have the battleship Hindustani, of 16,000 tons displacement, broken up at Belfast, more or less as a trial. It is claimed that the Ulster capital offers certain natural advantages for work of this description, but it is obvious that, other things being equal, the choice of a place for carrying out the breaking up operations must be predominantly influenced by its distance from the nearest point at which the scrap produced can be absorbed. A breaking up task of quite a different nature is the destruction of the old cruiser Ariadne, which was sunk by submarine off Eastbourne in 1917 and now lies on the sea bottom, a danger to navigation. This vessel, of 11,000 tons, was carrying 400 mines when torpedoed, and no guarantee can be given by the Trinity House authorities that the mines are now harmless. It is stated that already several firms have refused to make a tender for the work.

The Shipyard Ballot.

The meeting between the shipbuilding employers and the representatives of the Engineering and Shipbuilding Trade Unions Federation, referred to in our note last week, duly took place on Friday. The men's representatives endeavoured to secure further modification of the terms, but the employers declined either to modify or postpone the application of their proposals. As a two-thirds majority against acceptance of the terms was not recorded, no strike can be called. The men have bowed to the inevitable and are continuing at work. The employers reported that they had tested the market and were convinced that the reductions proposed were essential if the position of the industry were to be improved. New contracts based on the reduced labour charges had already been secured and would be added to with all possible speed by the builders and repairers as soon as possible.

Shepherd's Bush Exhibition Sold.

On Tuesday the Shepherd's Bush Exhibition Estate, together with all its buildings and other structures, was sold at auction in London. The estate extends to over 100 acres and accommodates buildings having a total capacity of 35 million cubic feet. Following the occupation by the Government during the war all dilapidations to the buildings have now been made good, and it is claimed that they are now as sound as they were when erected sixteen years ago. The buildings cost nearly a million pounds to erect. On Tuesday bidding for the buildings and site—leasehold—began at £250,000 and finished at £500,000. The purchaser, it is understood, is Mr. E. C. Gray, and, we gather, the intention is to reopen the exhibition for its original purpose, the holding of great international displays.

The London and North-Eastern's General Manager.

The Eastern Group of railways united under the name of the London and North-Eastern Railway, having selected Mr. William Whitelaw, of the North British, as chairman, has now chosen Mr. R. L. Wedgwood, of the North-Eastern, as its chief general manager. Mr. Wedgwood entered the service of the North-Eastern in 1896 and for a time was connected with the superintendent of docks' office at West Hartlepool. Thereafter in turn he was assistant general traffic manager, district superintendent at Middlesbrough, secretary to the company, divisional, assistant and chief goods manager, head of the passenger department, deputy general manager in succession to Sir Eric Geddes, and finally at the end of last year general manager. During the war he rose from a Major, R.E., to Director of Docks under the Director-General of Transportation in France. He was born in 1874 and is therefore not yet fifty years old. It is seldom, we think, that a railway official is in the happy position of having received experience of so many departments of railway operation such as has fallen to Mr. Wedgwood's lot. It will be noticed, however, that his experience of the engineering side is not of a direct nature, and that his appointment to the general managership is differentiated in this respect from the policy followed recently in most similar cases.

An Interesting Centenary.

The centenary of the foundation of the steel pen trade in Birmingham was celebrated in that city on Tuesday by a dinner given by Mr. Henry Mitchell and Mr. H. R. Mitchell to the manufacturers of steel pens in Great Britain. Proposing the toast of "The Birmingham Steel Pen Trade," Mr. Henry Mitchell said that in 1820 his grandfather, John Mitchell, was a maker of knife blades and other metal goods, but that about October, 1822, as shown by a ledger record, the first sale of steel pens was made, the price charged being 36s. per gross. Before that date steel pens were scarcely known and cost about 1s. 6d. each. Soon afterwards John Mitchell introduced the use of press tools, which reduced the price of steel pens to less than 1s. 6d. a gross. There were now eleven factories in Birmingham making steel pens, while one was established about a year ago in London. For the first forty years Birmingham enjoyed a virtual monopoly in this trade, but thereafter some Birmingham workmen went to France, with the result that there were now six steel pen factories in that country. There were more in Germany and America, while Japan was taking up the manufacture.

The Restoration and Preservation of Westminster Hall Roof.

THERE are many wonderful things about Westminster Hall roof, but not the least remarkable, in our view, is the fact that the work of preserving it for the benefit of future generations, begun in the early days of 1914, was continued, slowly, it is true, but without interruption, right throughout the dark years when the nation was fighting for its life, that side by side with the production of guns and shells and other munitions of war, it was found possible to spare material and time for the fabrication of the rods and plates and other steelwork with which the roof was, in an engineering sense, rebuilt. In the midst of an unexampled period of destruction it was found practicable to preserve from destruction an almost unexampled piece of mediæval architecture.

The story of how Westminster Hall roof has, after many previous attempts, mostly misjudged, at last been put into a condition which, with a little care, will preserve it for at least several hundred years, was told in a most entertaining and inspiring manner by Sir Frank Baines, of H.M. Office of Works, in a lecture delivered to the Institution of Mechanical Engineers last Friday night. Sir Frank as an architect was just a little less than kind to certain engineers and others who in the past had endeavoured to counteract the decay of the roof and to those who, being of the present generation, had suggested the use of simple straightforward steelwork conspicuously placed and painted vermilion for choice. Nevertheless, the fact emerged quite clearly that the preservation of Westminster Hall roof, as carried out under Sir Frank's supervision, is an engineering rather than an architectural undertaking, and would have been impossible without the hearty assistance of engineers.

The decay of the roof is the result of the long-continued work of the *Xestobium Tesselatum*, or wood-boring deathwatch beetle, an insect which, in the grub state, a stage of its existence lasting some three years, lives entirely within wood, deriving both its food and its supply of oxygen from the material which it excavates in the course of its boring operations. Records existing show that two hundred and fifty years or so ago the ravages caused by the beetle were sufficiently pronounced to attract attention and call for repairs. Its attacks have continued up to the present day, with the result that some of the main timbers have been hollowed out until they are mere shells within which a man might lie. The beetles are still busy, but the rising generation will, it is hoped, shortly meet an untimely end by poisoning from the very powerful insecticide with which the timbers have been treated in the course of the preservation work which is now nearly completed.*

Those who in bygone years took steps to defeat the work of the beetle showed varying skill and a varying understanding of the principle upon which Richard the Second's wonderful old master carpenter, Hugh Herland, constructed the roof in the years 1394–1399. In some instances the work done consisted simply of removing the decayed portions and inserting wood patches to restore the original outline. In another case a large cavity formed by the beetles had been filled by some genius with concrete. At various known and unknown dates additional timbers, bolts, tie rods, straps and shoes had been worked into the roof with very little consideration for, or understanding of, its structural principle, so much so that it long ago virtually ceased to be what it originally was, namely, a true hammer beam roof. In the course of the current work these later additions have been removed, so that the present undertaking merits the title restoration as well as preservation. At the same time it was quite out of the question to preserve the original principle of the roof. The weight and main stresses are to-day borne by steel framing cunningly worked into the timbering in such a way as to be all but invisible from the ground, the timbers themselves now serving merely as bracing to the steel work.

Some notes on the history of the roof and on the hammer beam principle upon which it was built were contributed by Mr. William Harvey to our issue of December 30th, 1921, while in our issue of June 9th, 1922, some details of the restoration work were published in connection with a visit of inspection paid to the Hall by the Newcomen Society. It is therefore largely unnecessary for us to record a good amount of Sir Frank Baines' lecture, for it was in some measure a repetition of what has already appeared in these columns. In order, however, that the work undertaken may be appreciated at its proper value, we reproduce in Figs. 1 and 2 two of the illustrations which accompanied Mr. Harvey's article, one of which shows a sketch of the roof as it was left by Herland, and the other a wooden model of one of the thirteen trusses. The roof is not a triangulated structure, for, with the exception of the hammer beams, all the timbers are in compression, while the trenails used at the joints definitely preclude the possibility of the transmission of tensile stresses. The main load in reality is transmitted down the wall posts on to the corbels half-way up the height of the wall. The structure of the truss is redundant in places, but, broadly speaking, it may be regarded as consisting of a pair of horizontal hammer beams fulcrumed on top of the wall posts and balanced by the vertical loads transmitted to them at one end from the hammer posts and the inclined thrusts of the lower principal rafters at the other end. The horizontal collar beam uniting the top ends of the hammer posts is an essential part of the structure, but the upper rafters and crown post may be regarded as a separate superimposed structure. The great arch rib extending from the corbels up to the mid point of the collar beam and the upper and lower curved struts which give the roof its trifoliate form, provide the necessary bracing for wind pressure. In the course of time the joint effect of the decay produced by the beetles, the shrinkage of the timber, the settlement and tilting of the side walls and the efforts of would-be restorers resulted in the great arch rib becoming the main bearer of the vertical load, the weight of the roof being transmitted to it through the tracery filling the space between it and the collar beam and the rafters. Since the erection of the roof the ridge piece has dropped about 18in., while the ends of the hammer beams have fallen from 12in. to 15in. Yet the structure adapted itself to these movements in a very wonderful manner. It may be doubted whether a roof of any other material or a wooden roof designed on a different principle could have done likewise.

The chief difficulty experienced by the original builders was undoubtedly the securing of timber of suitable size, for not only were the members of exceptional length, but some of them, as, for instance, the hammer posts, had to be made from trees having branches of the right size and at the right height to provide the abutments for other members—in the case of the hammer posts, for the base of the upper curved struts. Existing records show that the wood used was English peduncular oak grown in the Sussex Weald and planted probably in the eighth century. The trees were felled in the years 1393 to 1396, and as the roof was finished in 1399, there could not obviously have been much time for seasoning it. The timber required for the current work of restoration is also unseasoned peduncular oak, and has also been obtained from the Sussex Weald, but, alas! of all the trees available there is only one giant from which one hammer post might have been made. Yet Hugh Herland had to, and did, find twenty-six such trees in his day. In places it has been possible to obtain undecayed portions of wood from some of the timbers removed from the roof. Such wood, when tested, shows undiminished strength when compared with modern timber. This fact, in Sir Frank Baines' estimation, and we think engineers may well admit it, establishes English peduncular oak as one of the finest structural materials available to us. No steel or stone would have given the same length of life.

In setting about the work of restoring and preserving the roof it was laid down that every possible atom of the mediæval structure should be left intact for the benefit of posterity, that all the additions introduced by the restorers of previous days, in so far as they conflicted with the principle of the roof, should be removed, and that the new work added should be as nearly as possible invisible from the floor level. Sir Frank Baines does not, however, agree with the principle observed by some restorers of historical structures that no use should be made of any material or process which was foreign or unknown to the original builders. It is justifiable, he holds, to make every use of modern developments provided the modern materials are not allowed to impinge upon the old. The main material used in the restoration work, therefore, is not oak, but steel in the form of plates and tie rods. In Fig. 3 we reproduce a drawing kindly lent to us by the Office of Works, which shows how the steel has been applied to the old timbers. On page 495 we give three views showing the work in progress. The upper view illustrates the hall as seen from the north entrance doorway. The trusses in the foreground have been fully reinforced, although all that is readily noticeable from the ground level, it will be observed, is the steel tie rod running behind each of the arch ribs in their upper portions. In the background is to be seen the steel staging erected for the purpose of supporting the old trusses—two at a time—and of applying the steel reinforcement. The first of the two lower views shows the foot of one of the principal rafters and the reinforcement over the great arched rib. It also shows part of the steel staging. The other view shows the end of a main collar beam and the principal rafters, and illustrates the manner in which the upper portion of the principal is supported while the reinforcement is being fixed to the lower portion.

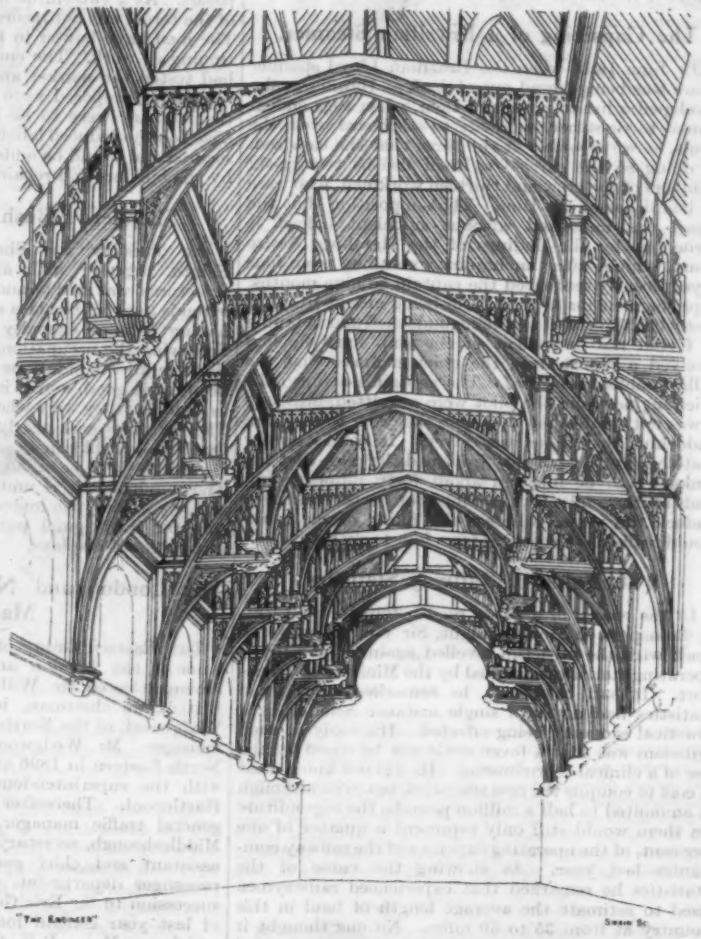


FIG. 1—HUGH HERLAND'S ROOF, WESTMINSTER HALL

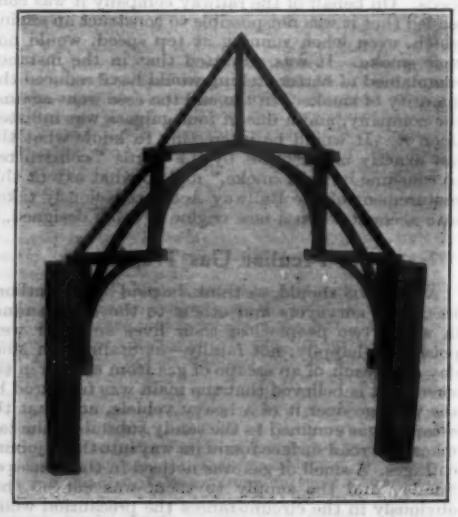


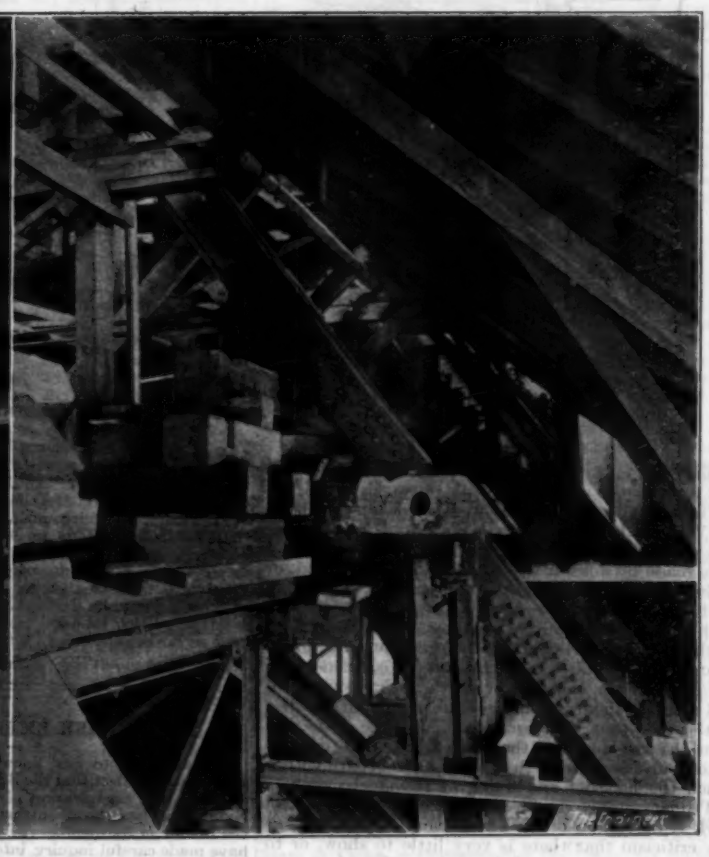
FIG. 2—MODEL OF A TRUSS

* The insecticide first tried was a mixture of tetrachlorethane and trichlorethylene, but had to be given up because of the very poisonous action which it exercised on the liver, and the consequent necessity for complicated breathing apparatus which had to be worn by the workmen when applying it. The substance finally adopted was a mixture of orthoparadichlorbenzene and cedar wood oil. It has a very strong pungent odour, which is apparently harmless, and which quickly disappears after the wood has been treated with it. A baulk of oak from the roof, was on exhibition in the lecture hall on Friday night. It had been treated with the insecticide in the morning, with the result that the ground floor and basement of the building were surcharged with a heavy odour, which to some was far from pleasant.

REPAIRING WESTMINSTER HALL ROOF

VIEW FROM NORTH ENTRANCE DOORWAY, SHOWING STEEL STAGING

PRINCIPAL RAFTER AND ARCH RIB



PRINCIPAL RAFTER AND COLLAR BEAM

The drawing of the steel work is very nearly self-explanatory. The reinforcement may be described as a triangulated structure composed of forged rods, plates, angles and tees applied within the space between the principal rafters and the rear face of the upper two-thirds of the great arch rib. The reinforcement of the collar beam is applied down its central plane, an aid to invisibility rendered possible by the fact that this beam was made in two side-by-side parts by the original builders. In a similar manner advantage was taken of the fact that the tracery between the lower principal rafters and the middle third of the arched rib was in two parts, to secure substantial invisibility by disposing the plate and tee reinforcement in the intervening space. At the level of the purlins rolled steel joists are run from truss to truss, the expansion of the roof as a whole being accommodated by supporting the joists on bronze rubbing plates. It is to be noted that the various steel members are united to each other not by rivets but by bolts. Before a reinforced truss is lowered down on to the walls it is strained by hydraulic jacks to a calculated extent so that its weight and that of the roofing slates, &c., when re-applied shall not exert any tendency to spread the walls outwards.

The forged steel tie rods were made at Parkhead by William Beardmore and Co., Limited, while the rest of the steel reinforcement and the steel staging were made by Joseph Westwood and Co., Limited, of Millwall. Sir Frank Baines, in the course of his lecture, paid what we feel sure was well-merited testimony to the interest and ability shown by Messrs. Westwood in the work undertaken by them. Unusually great accuracy was required in the manufacture and marking off of the various members, while the task of supplying and erecting them was made doubly difficult because of the fact that no two trusses, in some cases not even the two faces of the same truss, were exactly similar, and because of the very confined space within which the hoisting and fixing of the steel members had to be conducted. Sir Frank admits that the steel work is by reason of its design very expensive, but any criticism that there is very little to show, or to see from the ground level, for the considerable expenditure incurred will be accepted by him not as censure but as a compliment. The work is now approaching completion, and it is hoped that by the end of March or early in April it will be found possible to open the hall for public inspection.

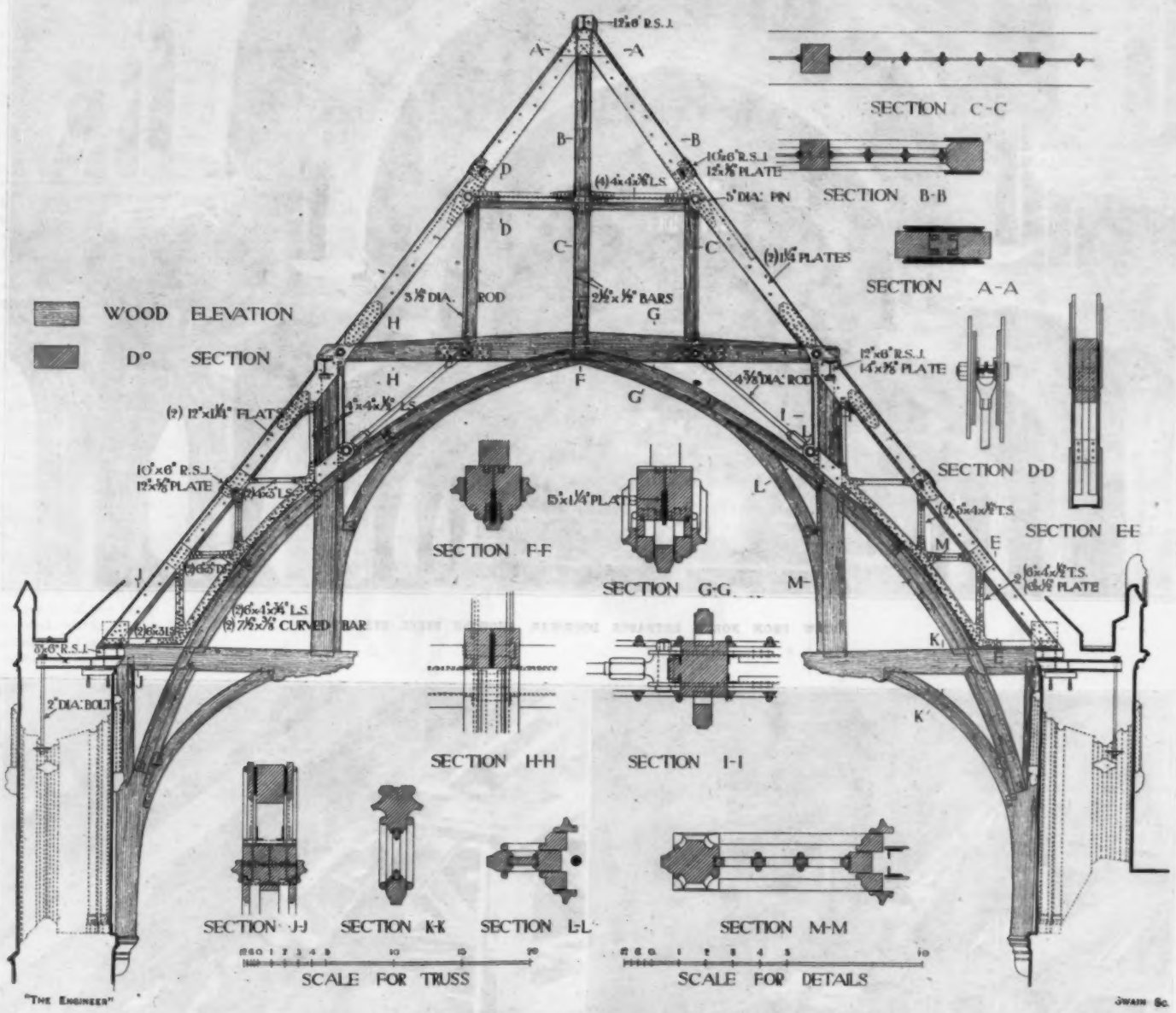


FIG. 3—STEEL REINFORCEMENT, WESTMINSTER HALL ROOF

THE WEST GERMAN METAL INDUSTRY.

It is reported in the *Berliner Tageblatt* of October 25th, in an extract forwarded to the Department of Overseas Trade by the Commercial Secretary at Cologne (Mr. C. J. Kavanagh) that the West German metal industry has experienced a great decline during the past month in new orders both for home and abroad. Some works, although working hours have been restricted, have only sufficient orders on hand to last them for a few weeks. It is feared that there is very little hope of improvement, as, in spite of the exchange, it is impossible to obtain large orders from abroad, and that work restrictions and a reduction of workers will become necessary during the month of November. Unemployment is equally on the increase in the wagon building and locomotive industry, especially as the State railways, owing to their financial position, are not in a position to place large orders. The orders received by some firms in this line have decreased to 25 per cent. of former orders. The Hohenzollern A.G. für Lokomotivfabrikation at Düsseldorf has reduced its working hours to six, and the Rheinische Metallwaren und Maschinenfabrik which, owing to its connection with the Otto Wolff-Linke-Hofmann-A.E.G.-Krupp group, receives a certain amount of support, is experiencing shortage of employment in its department. The Phönix A.G. für Bergbau und Hüttenbetrieb at Düsseldorf has restricted working hours in its thick plate rolling mills, as only small orders are being received from the wharves. Dismissals have so far been avoided by transferring workers to other departments.

THE BRITISH EMPIRE EXHIBITION.

It has come to our knowledge that a statement is current to the effect that the British Engineers' Association, to which the organisation of part of the British Empire Exhibition has been entrusted, is showing a bias in the favour of its members in the allotment of space. We have made careful inquiry into this matter, and can find no grounds for the statement.

The agreement between the Exhibition company and the British Engineers' Association contains the following clause: "All British manufacturers of engineering plant, machinery and accessories shall be eligible to exhibit in the section whether members of the Association or not."

At the first meeting of the Exhibition Committee of the B.E.A., held on May 25th last, it was resolved unanimously that all engineering firms wishing to exhibit, whether members or not, should have equal opportunities of securing space according to the priority of their provisional applications if subsequently confirmed by definite and binding applications. Furthermore, in order to safeguard the interests of non-members of the Association, more especially in regard to the allotment of space positions, the following gentlemen were invited and consented to serve on the Exhibition Committee:—Sir John Dewrance, K.B.E., Sir Arthur Duckham, K.B.E., Engineer-Vice-Admiral Sir George G. Goodwin, K.C.B., and Captain H. Riall Sankey, C.B.

Under its agreement with the Exhibition company, the Association will receive a commission on all amounts paid for space let in the shipbuilding, marine, mechanical and general engineering section of the Exhibition, and its members will, of course, benefit thereby; but they will receive no more consideration than other applicants for space. The B.E.A.M.A. has a similar agreement with the Exhibition company, with respect to the electrical section of the Exhibition, and the two sections, mechanical and electrical, will occupy the whole of the space in the Machinery Hall, and will be divided by the main avenue running from east to west. We understand that the final forms of application for space will be sent out on the 15th inst. We may add that up to the present no spaces have been finally allotted.

Faraday House Old Students' Association.—Old students are reminded that the annual dinner will be held at the Hotel Cecil on November 17th, at 6.30 for 7 p.m., with Mr. P. V. Hunter, M.I.E.E., in the chair. As a large attendance is anticipated, early application for tickets is desirable.

Twenty-one Years of Research.—A booklet just issued by Rudge-Whitworth, Limited, of Coventry, celebrates the twenty-first anniversary of the research laboratory of that company, which, it is claimed, was the first of its kind in this country, and has been the model for several others that have been organised since 1901. The greater part of the reading matter in the booklet is concerned with the evolution, in the laboratory, of Eternite, a case-hardening compound; but there are a few notes on other inventions, such as the rectified plug gauges which we recently dealt with, pyrometers, Brinell testers, and so forth. The laboratories, it should be pointed out, are at the Sparkhill, Birmingham, works of the company.

Railway Matters.

No reliable information on the wearing qualities of cast iron brake blocks exists, and it is satisfactory to learn that the Cast Iron Research Association has an investigation in hand.

Fares on the Underground are to be reduced as from January 1st. The three-halfpenny minimum fares for short distances will be retained. Corresponding reductions are to be made in season tickets.

It is reported that the electrification of the Tokaido Railway is to begin next year, and that nine electric locomotives will be built for special express trains, 46 for ordinary express trains, 107 for local goods and mineral trains, 48 for express and heavy goods and mineral trains, and 81 for shunting.

Public notices have been given by the Great Central, Great Eastern, Great Northern, North-Eastern, North British and Great North of Scotland companies of meetings of their respective proprietors and debenture-holders on Friday next, the 17th, for the purpose of approving the scheme for the amalgamation of those companies.

Writing of the electrification of the Buenos Aires and Western Railway in the *Westinghouse International*, Mr. Lynn G. Riley says that when plans were first made for this electrification there was provision in all electrical equipment for a possible change to 1600-volt operation, but there seems to be no immediate prospect of such a change being made.

The absorption scheme for which the London and South-Western Company is responsible is now complete except as regards the Freshwater, Yarmouth and Newport (Isle of Wight) Railway, which is in the hands of a Receiver. The scheme, with that exception, comes up for approval by the proprietors of the London and South-Western Railway on Friday next.

The official announcement is made that, as soon as the Board of the London and North-Eastern Railway is confirmed by the amalgamating companies, it is proposed to appoint Mr. R. L. Wedgwood as the chief general manager, and Sir Francis Dunnell, Bart., as the chief legal adviser to the new company. For the time being there will be no change in the local management of the North British and Great North of Scotland Railways.

The Press Association is our authority for stating that the railway unions have decided not to accept the companies' proposals for modifications of the national agreements. The companies may now take their plan to the Central Wages Board. If that be so we are inclined to the opinion that no decision will be arrived at there, and thus it will be for the National Wages Board—on which the users of the railways are represented—to decide as to the justice of the companies' case.

Notice has been given by the Hayling Railways Company of a meeting to confirm the agreement for the absorption of that railway by the London, Brighton and South Coast Company. A general meeting of the proprietors and of the debenture and shareholders of the London, Brighton and South Coast Railway will be held on Thursday next to approve the Railways (Southern Group) Amalgamation Scheme, 1922. A similar meeting of the proprietors of the London and South-Western Railway will be held the following day (Friday).

As long ago as July 1st of last year we printed a leading article on the dispute between the North British Railway Company and the Ministry of Transport as to sums paid for upkeep—mainly of wagons—which were in excess of the amount spent during the basic year of 1913. At that time the sum in dispute was £430,000, and as it had been deducted by the Ministry from the payments on which the railway company had been relying to pay its usual dividends, some portion of the latter had to be withheld. The question has dragged on since then, and two further half-yearly dividends have been similarly effected and, moreover, the amount has grown to £1,120,000. We are glad now to hear that a settlement has been arrived at.

Few people are aware of the fact that the quickest route from London to the London, Brighton and South Coast Company's Portsmouth line is *viâ* the London and South-Western route through Raynes Park to Epsom, whence the line to Leatherhead is jointly owned by the two companies named. Not only is this route the shorter, but it avoids the sharp reverse curves at Mitcham Junction, which call for a speed restriction of 20 miles per hour, and the steep gradient from Carshalton to Sutton. Perhaps, under grouping, advantage may be taken of this route. A circular service through Guildford should also be possible, going by the South-Western and returning *viâ* the Brighton Company's system and *vice versâ*.

The Eastern Bengal Railway, says *Indian and Eastern Engineering*, has formed plans for the spending during the next five years of the six and a-half crores of rupees allotted to it by the Government of India. These schemes include the completion of the extension of the broad gauge from Santahar, the present terminus, to Parbatipur; the provision of increased shed accommodation at certain large stations; the instalment of power-houses for the supply of electricity for lighting and power at Ranaghat, Siliguri, Katihar, Lalmanirhat, Saidpur; and the addition of certain passenger facilities at stations, such as the boring of wells, the erection of over-bridges and the improvement of the arrangements for the comfort of passengers at Siliguri.

The report by Colonel Mount on the collision of August 4th last at Birmingham, New-street, shows that the driver of the first portion of the down "Sunny South Special" did not know the road through Birmingham, and a telegram in code was sent from Willesden to Rugby for a pilot. This telegram was not understood, and no pilotman was in readiness, so the fireman of a pilot engine, who knew the road, volunteered to serve, and he went. The entrance to New-street station from the south is very difficult, and the pilot allowed the train to enter at an unsuitable speed, with the result that it overshot the home signal at the middle of the platform, and ran into a standing train. Colonal Mount concludes his report with the suggestion that firemen should have a practical examination as to their qualifications to work a train safely over a route they claim to know.

Notes and Memoranda.

The first commercial application of the mercury vapour turbine is forecasted by the news that the public supply company at Hartford, U.S.A., has ordered a 2500 kilovolt-ampère set. Oil fuel will be used under the mercury boiler, which will operate at a fairly low pressure. The mercury vapour, after passing through the turbine, will be condensed in a special "condenser boiler" designed to furnish steam to a steam turbine mounted coaxially with the mercury vapour turbine.

In a short article on grinding as a metal-removing process, the *American Machinist* says that while a few years ago the amount of metal removed in grinding might be about 0.18 cubic inches per minute, with some of the latest American machines employing inserted segmental abrasive blocks as much as 23 cubic inches of metal (cast iron) can be removed in a minute, and, in fact, even larger amounts have been taken off by this process, while the surface which results meets all the requirements of the engineer.

Experiments carried out in America on the treatment of carbon monoxide asphyxia have shown, according to the *Gas Journal*, that when breathing oxygen the rate of elimination of carbon monoxide is somewhat more rapid than when the subject breathes merely air, but that the elimination is enormously accelerated when the inhalation consists of oxygen, plus carbon dioxide. A blood concentration of carbon monoxide of 40 to 50 per cent. saturation (a dangerous amount) was reduced to 10 or 12 per cent. (a quite harmless amount) in half an hour.

An instance of very long distance transmission of power is given in the *Electrical World* by W. E. Mitchell, of the Alabama Power Company. The cotton mills and other industries in the Carolinas were short of power owing to the low water in the rivers and the car shortage at the coal mines, and the company has been supplying 35,000 horse-power a day to meet the deficiency. The power was generated at the Gorgas and federal plants at Muscle Shoals and at the company's Birmingham plant, and was transmitted to Greenville and Spartanburg, South Carolina, thence as far east as Raleigh, and north to Greensboro' and Henderson, North Carolina, some of the power being transmitted 600 miles.

During a recent meeting of the Faraday Society, Professor Crommelin read a paper on low-temperature research, in which he described the difficulties encountered in attaining very low temperatures. The evaporation of liquid helium under very low pressures was the only feasible method, he said, of obtaining temperatures below − 269 deg. Cent., and to obtain this liquid helium, liquefied air and liquefied hydrogen had to be utilised in comparatively large quantities. Actually a temperature lower than 1 deg. Absolute has been attained, and this appears to be the limit, so far as can be foreseen at present, failing the unlikely eventuality of the discovery of some new gas with a lower critical temperature than helium.

Experiments made at the University of Wisconsin show that thin deposits of gold, silver, copper and brass electro-plated on zinc will in time disappear, having been diffused into the zinc. Nickel does not appreciably diffuse, and, therefore, by previously coating zinc with nickel the diffusion of the other metals is prevented. These results are in extension of results that are recorded by Roberts-Austen. The old process of making steel is an example of the interpenetration of solids. That some of the common metals, especially those of low melting points, give off appreciable vapours at ordinary temperatures has long been known. These vapours will affect a photographic plate, the action being entirely different from that of radioactivity.

The capacity of the Panama Canal is, according to Mr. J. K. Baxter, who writes on the subject in the *Engineering News-Record*, ample for all likely requirements during the next thirty years. In discussing the possibility of deepening the canal to sea level he says that the undertaking bristles with difficulties, and it has never gained the support of any American engineer who has served on the Isthmus and is familiar with local conditions. Nothing in the present situation justifies this questionable improvement, and if some thirty years hence it becomes necessary to provide for the passage of a greater number of ships than the present lock canal can handle, it is probable that even then this sea-level project will be rejected for some more economical alternative.

Trade and labour conditions were discussed at considerable length at the recent quarterly meeting of the American Malleable Castings' Association held in Cleveland, Ohio. Reports by members indicated that malleable foundries were now operating at about 75 per cent. of normal capacity. During the ten years that the Association has conducted its research work tensile strength and elongation have constantly exceeded the specifications of different engineering societies. The metal produced from co-operative effort between scientists and practical foundrymen is called "certified malleable." On October 1st, 1922, new specifications of 50,000 lb. tensile strength and 10 per cent. elongation became effective, representing the remarkable increase of 32 per cent. in tensile strength and 100 per cent. in elongation over the requirements when the Association's research work started.

The question of carefully passing railway sleepers before treatment was very prominently brought out by experiments carried out in India and described in Technical Paper No. 231 by Mr. R. S. Pearson. With few exceptions they were not inspected, with the result that a few sleepers of each batch had to be rejected for mechanical defects soon after they were laid down. The great importance of laying treated pine sleepers heart up and sap down was also a noticeable feature of the results, while the necessity of adzing and boring sleepers before treatment whenever possible was clearly demonstrated in the case of the Dipterocarp sleepers which only failed under the rail seat, while the rest of the timber was in a sound condition. Too much care cannot be taken in selecting the grade of creosote to be used, analysis of which should be made of every bulk sample received for treating sleepers. And lastly, it must not be forgotten that unless the timber is air dry the treatment will fail.

Miscellanea.

An expedition is to be sent to Morocco shortly to investigate the deposits of lead and zinc ores near Oudja.

Prospecting work which has recently been carried out in Rhodesia indicates the existence of extensive deposits of copper near the Zambesi.

The output of platinum in all the Ural mines from January 1st to July 15th of this year amounted to 700 lb.; 111 grains of iridium were also recovered.

Preparations are being made by the Colombo Municipality for an early start on the work in connection with the building of the new Town Hall in that city.

Samples of ore from the copper area recently discovered in the Vesterbossen Province of Sweden was said to be of better quality than any previously found in Scandinavia.

The Finance Committee of the Ceylon Legislative Council has approved the supplementary provision of 27,000 rupees to meet the requirements of dredging in Colombo harbour.

Copper production in Japan during June was 2 per cent. below that of June, 1921. Japanese consumption of copper now aggregates about 4500 tons monthly, while the output is approximately 3500 tons.

The output of coal in Great Britain during the week ended October 21st was the largest in any week since May, 1919. It amounted to 5,355,400 tons, as compared with 5,254,000 tons in the preceding week, and 4,236,000 tons in the corresponding week last year.

Persistent statements are being circulated to the effect that all or the majority of the parts of the new 20 horse-power Rolls-Royce chassis are manufactured at the works at Springfield, Mass., of Rolls-Royce of America, Inc. We are asked by the firm to state most emphatically that there is not an atom of foundation for this statement.

As the result of negotiations between the Japanese and Chinese authorities, arrangements have been made for the erection of electric power transmission lines between Fushun and Moukden, and the work of placing the standards is nearly finished. An additional generating unit of 1500-kilowatt, for the Chinese Electric Light Company (Moukden), has been delivered.

Preparations are under way for the exploitation on a large scale of the potash deposits near Suria, in the Province of Lerida, Catalonia. A Belgian concern is now building a plant at Suria, which, it is said, will have a production capacity more than equal to the total Spanish consumption. To facilitate the transportation of the potash, a railway to Manresa has been constructed, and plans have been completed to extend this line to the port of Barcelona.

A scheme of hydro-electrical development on the east branch of Bear River, Nova Scotia, at a probable cost of 11,150,000 dollars, which would supply the north shore of Nova Scotia from Yarmouth to Middleton, was recently outlined by Mr. K. H. Smith, chief engineer of the Nova Scotia Water Power Commission. The work had, he said, so far advanced that, within a very short time the Commission would be prepared to suggest a definite contract for the approval of the town. Distributing stations under the plan would be at Middleton, Bridgetown, Annapolis, Bear River, Digby, Weymouth, Port Maitland and Yarmouth.

Signal Hill oil field at Long Beach is, according to the *Standard Oil Bulletin*, the greatest development in California petroleum history. Discovered in June, 1921, the field, through intensive and very rapid development, has been brought to a production of an average of approximately 95,000 barrels of oil per day. The field covers only 205 acres of land and has an average of one well to every 1.54 acres. A study of the performance of various wells of this field gives certain interesting mathematical conclusions. For example, four selected but typical wells were, early in August, producing 8262 barrels per day. Toward the end of September, six weeks later, this production had dropped to 5049 barrels per day. Thus, while total production for the field has risen, owing to new completions, the older wells, quite naturally, have fallen off. The decline appears to be quite rapid.

The Sheffield Chamber of Commerce is obviously opposed to the proposed smoke abatement legislation, in view of the fact that it has recently circulated a statement in which it is suggested that the treatment of high carbon steels cannot be satisfactorily dealt with in smokeless furnaces. The heating of steel sheets to produce high-class finish cannot, it is said, be carried out by any known process which does not involve the creation of black smoke. Further it is claimed that attempts to reduce the smoke trouble by increasing the amount of gas used in gas-fired furnaces has proved a failure. In the opinion of the manufacturers the effect of such an Act would be the shutting down of all plant dealing with high carbon, high speed and alloy steels, and all high-grade steel sheets, with the result that Sheffield would be in danger of suffering damage to its reputation for high-class steels.

During the decade 1911-20 the value of the textile, agricultural and other machinery imported into China increased from 6,561,020 to 22,536,254 Haikwan taels, and the figures for 1921 constituted a record. Apparently, the greatest increase has occurred in the imports from the United States and Canada, the value of which rose from 382,054 to over twelve million taels in 1920, while Great Britain's share only advanced from 2,330,209 to 5,229,026 taels. Though Chinese trade is not brisk at present, machinery of all kinds, and particularly electrical, textile, mining and agricultural, is being sold, and if the Great Powers could only settle a method of financing the new railways that are projected there would be a rapid revival of trade of the exporting countries. Undoubtedly Great Britain has suffered most and the United States have gained most from the war, and though some progress has been made in recovering some of our lost trade greater efforts are necessary. In view of the progressive trend of things in China, notwithstanding the temporary dulness of most trades, it is believed that in the near future there will be large orders for further plant.

SOME RECENT MOTOR CAR CHASSIS

(*For description see page* 489)

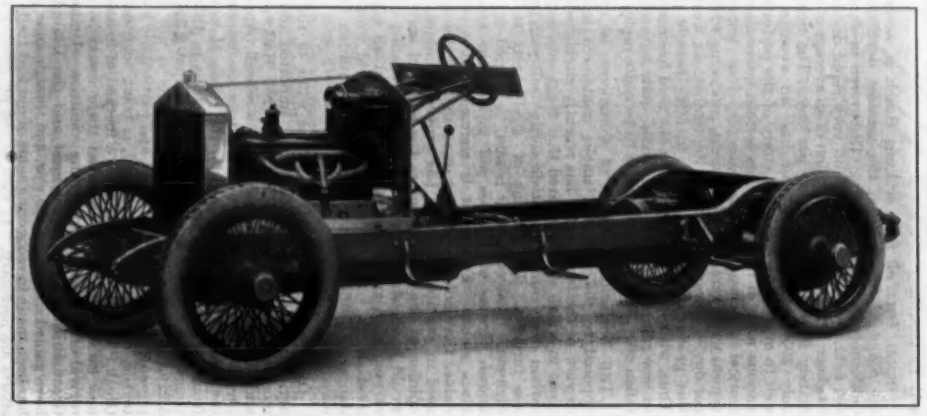


FIG. 14—20-H.P. ROLLS ROYCE CHASSIS

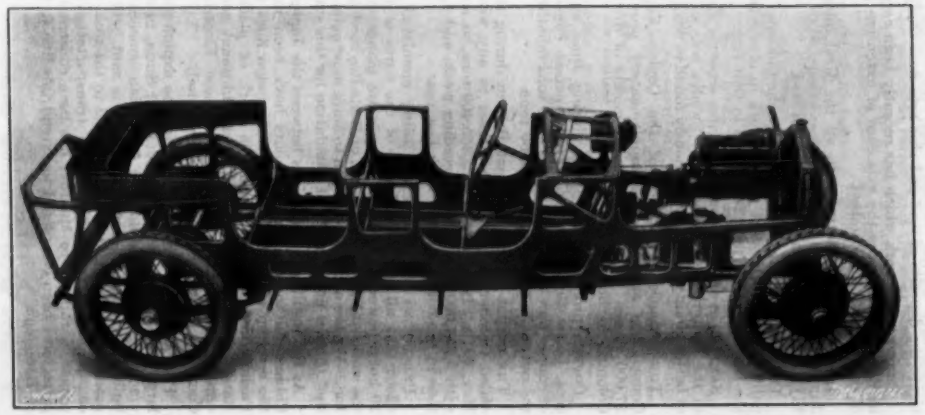


FIG. 15—FRAME AND BODY CONSTRUCTION OF 13.9-H.P. LANCIA CAR

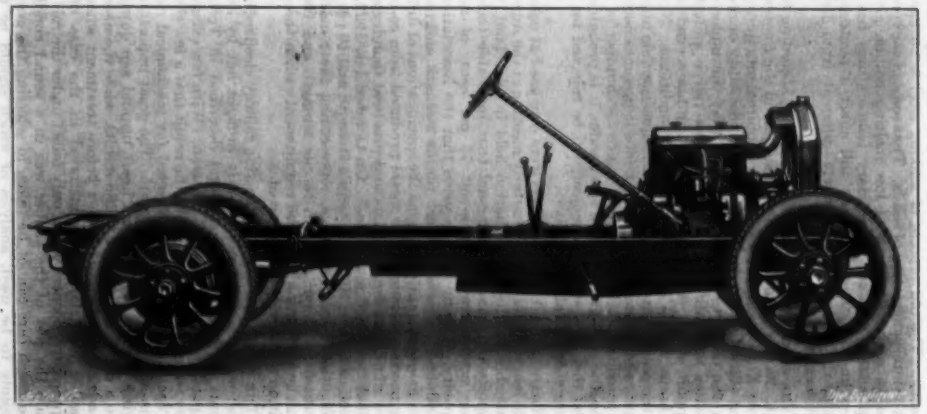


FIG. 16—15.9-H.P. HUMBER CHASSIS

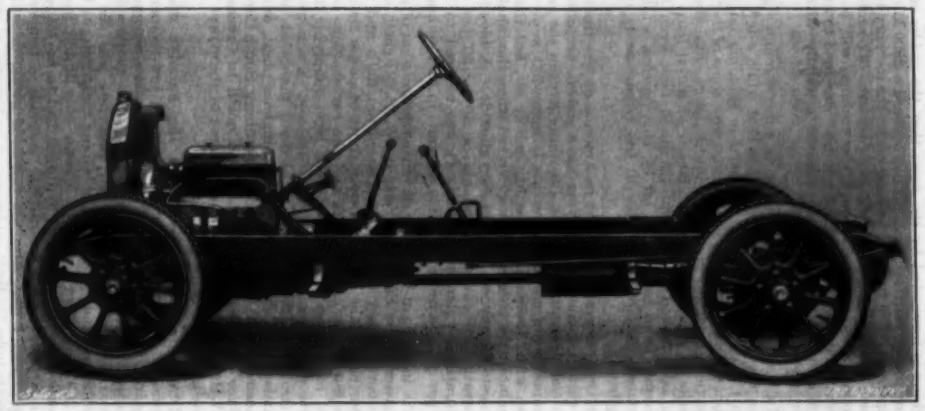


FIG. 17—11.4-H.P. HUMBER CHASSIS

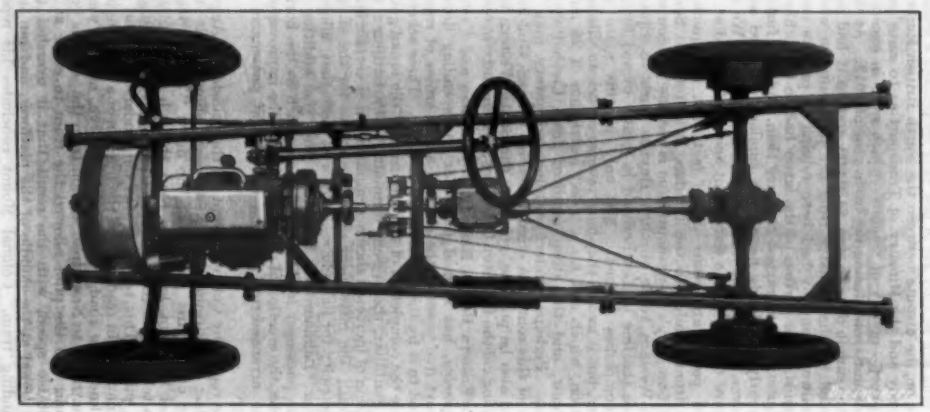


FIG. 18—PLAN VIEW OF 8-H.P. GWYNNE CHASSIS

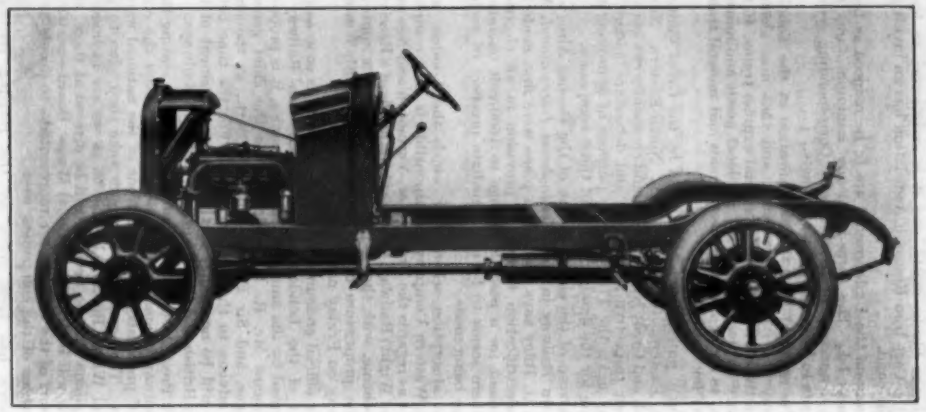
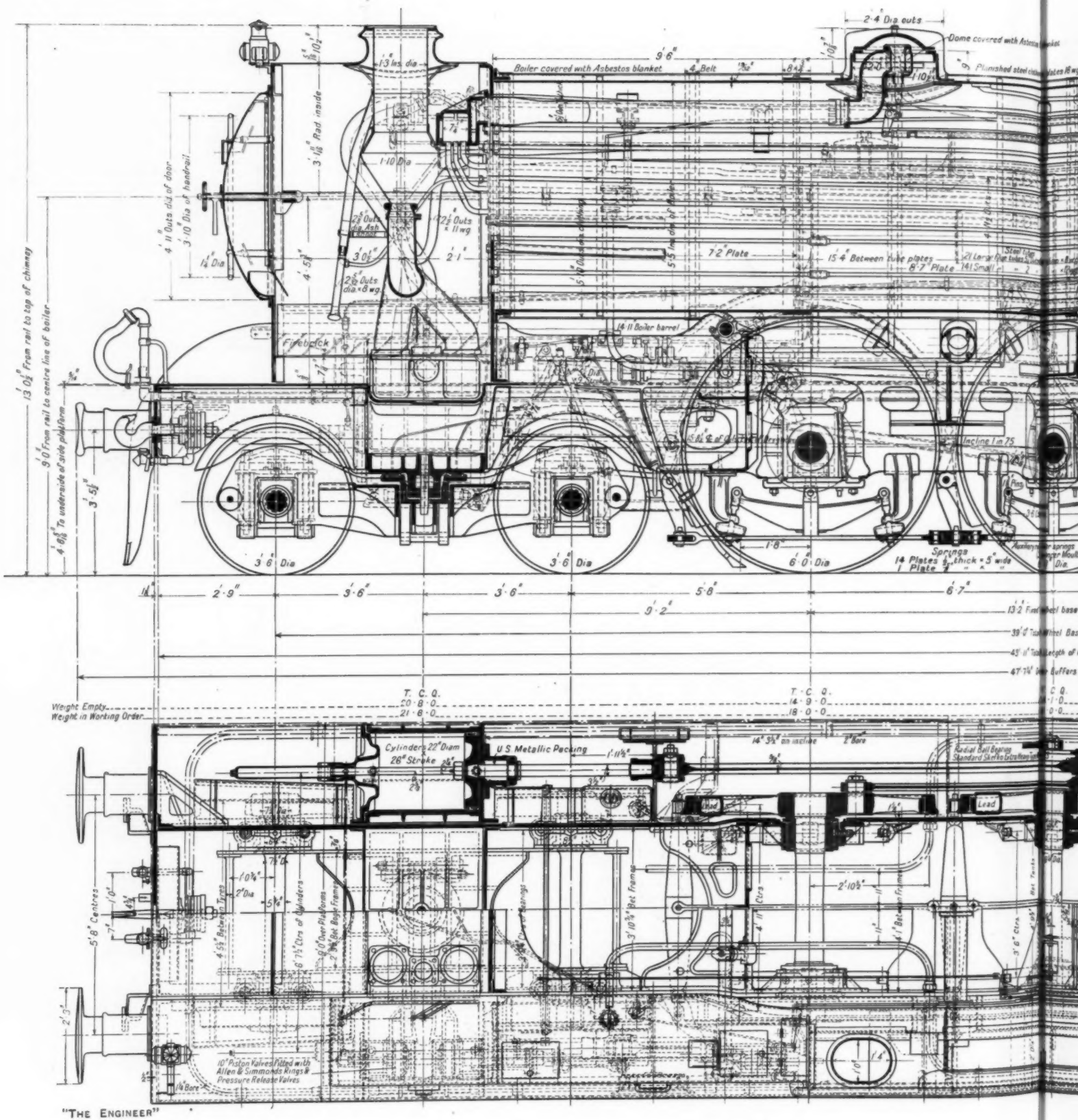


FIG. 19—12-14-H.P. CROSSLEY CHASSIS

GLASGOW AND SOUTH-WESTERN RAILW

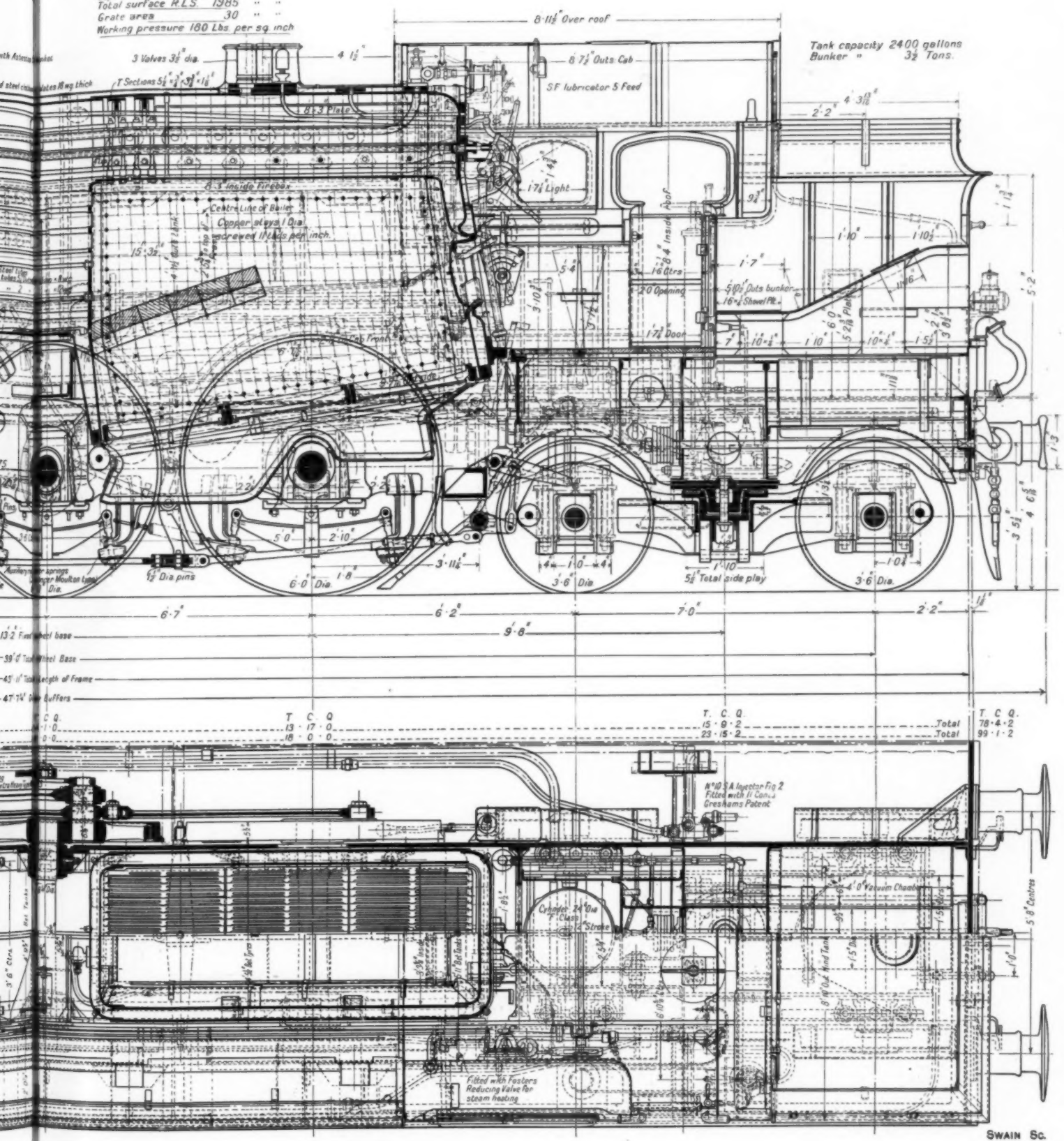
MR. ROBERT H. WHITELEGG, KILMA



"THE ENGINEER"

RAILWAY—BALTIC TYPE TANK ENGINE

ELEGG, KILMARNOCK, ENGINEER



AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
EGYPT.—Cairo Express Agency, near Shepheard's Hotel, Cairo.
FRANCE.—Boyveau and Chevillet, Rue de la Banque, Paris Chapelot and Cie., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. Combridge and Co., Bombay; Thacker and Co., Limited, Bombay; Thacker, Spink and Co: Calcutta.
ITALY.—Maglioni and Strini, 307, Corso, Rome; Fratelli Treves, Corso Umbarto 1, 174, Rome; Fratelli Bocca, Rome; Ulrico Hoepli, Milan.
JAPAN.—Maruzen Co., Tokyo and Yokohama.
AFRICA.—Wm. Dawson and Sons, Limited, 7, Sea-street (Box 49), Capetown.
C. Juta and Co., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—Gordon and Gotch, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
Melville and Mullen, Melbourne.
Atkinson and Co., Gresham-street, Adelaide.
CANADA.—Dawson, Wm., and Sons, Limited, 67, Queen-street East, Toronto.
Gordon and Gotch, Limited, 132, Bay-street, Toronto.
Montreal News Co., 386-388, St. James-street, Montreal.
Toronto News Co., 42, Yonge-street, Toronto.
CEYLON.—Wijayartna and Co., Colombo.
JAMAICA.—Educational Supply Co., Kingston.
NEW ZEALAND.—Gordon and Gotch, Limited, Wellington and Christchurch; Upton and Co., Auckland; J. Wilson Craig and Co., Napier.
STRAITS SETTLEMENTS.—Kelly and Walsh, Limited, Singapore.
UNITED STATES OF AMERICA.—International News Co., 83 and 85, Duane-street, New York; Subscription News Co., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—British and Colonial Press, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—Agence Vox, 7, Rue de Sur ne, Paris (VIIIe).
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive The Engineer weekly and post free. Subscriptions sent by Post Office Order must be made payable to The Engineer and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 9d.
Yearly	£3 3s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum
Thick paper edition .. .. £3 3s. 0d. ,,

*** Reading Cases, *to hold two copies of* The Engineer, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "The Engineer Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two page Drawing of a Baltic Type Locomotive for the Glasgow and South-Western Railway. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

*** *If any Subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, The Engineer *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

The Engineer, November 10th, 1922.

	PAGE
Skimming Rivers for Irrigation Water. (Illus.)	485
Institution of Electrical Engineers	486
Literature	487
The Institution of Civil Engineers	488
The Motor Car Shows.—No. II. (Illus.)	489
High Compression High Speed v. Low Compression Moderate Speed	492
Problems in Chemical Industry	492
A Seven-day Journal	493
The Restoration and Preservation of Westminster Hall Roof. (Illus.)	494
The West German Metal Industry	496
The British Empire Exhibition	496
Railway Matters	497
Notes and Memoranda	497
Miscellanea	497
Leading Articles—	
International Telephony	499
Fibre in Metals	499
The Institution of Civil Engineers.—Dr. Maw's Address	500
Irish Railways	501
Locomotive Cut-off and Horse-power	501
Australasian Engineering Notes	501
New Baltic Tank Locomotives. (Illus.)	502
French Production of Cast Iron	502
Developments in Radio Telegraphy and Telephony	502
The United States Super-power Survey	503
Slag Encrusted Boiler Tubes. (Illus.)	504
Letters to the Editor—	
Local Electricity Supply v. Bulk Supply	504
Gaseous Fluid Ejector	505
The Bases of Modern Blast-furnace Practice	505
Provincial Letters—	
The Midlands and Staffordshire	507
Lancashire	507
Sheffield	508
North of England	508
Scotland	508
Wales and Adjoining Counties	509
Personal and Business Announcements	509
Launches and Trial Trips	509
Current Prices for Metals and Fuels	510
French Engineering Notes	511
British Patent Specifications. (Illus.)	511
Forthcoming Engagements	512

Two-page Supplement—Baltic Type Locomotive, Glasgow and South-Western Railway.

DEATH.

On November 6th, suddenly, John Thomson, late of Finnieston Engine Works, in his 83rd year.

THE ENGINEER.

NOVEMBER 10, 1922.

International Telephony.

With the notable exception of radio communication, the so-called weak current side of electrical engineering does not seem in these days to receive the appreciation it deserves. Progress in the heavy branches of the industry has to a large extent eclipsed the work of those who have confined their activities to telegraphy and telephony, yet a little investigation will readily show what an immense amount of thought and labour has been given to systems of electrical communication which involve the use of wires. An inspection of a modern automatic telephone exchange, for instance, is sufficient to convince anyone who may have been sceptical about the matter that the modern telephone engineer is every bit as ingenious and as worthy of admiration as any other class of engineer, and that telephonic communication in these days is really a wonderful affair. In selecting Mr. Frank Gill for its new President, therefore, the Institution of Electrical Engineers has chosen a man who represents a by no means insignificant branch of the electrical industry. The Institution was, of course, originally brought into existence mainly for the benefit of those engaged in telegraph and telephone work, and it is gratifying to find that although the electrical profession has since penetrated into many other important channels, the significance of the weak current branch of the industry is at any rate still recognised by those who govern the Institution's policy.

As everyone expected, Mr. Gill's inaugural address was confined mainly to the work with which he has for many years been closely and prominently connected; but it is doubtful, we think, if many, except those who have closely studied the matter, imagined that he would suggest that drastic and far-reaching telephone reforms are needed in Europe. Given adequate facilities, he contended, there is traffic waiting to be handled between the cities of Europe in the same manner as it is handled in the United States, where the telephone systems are of a gigantic character. It is not, in the opinion of the new President, putting the matter too strongly to say that through-telephony in Europe under present conditions can never be worth the name of a service. So far as distance is concerned, there are no difficulties in the direction of constructing lines which can be operated at commercial rates, and provide all the through communication that is necessary. In the United States there exists a long-distance telephone service which might be copied with advantage in Europe. The direct distance between Brussels and Athens or between Paris and Constantinople, for example, is 1300 miles, which is about the same distance as between New York and Omaha or Chicago and Salt Lake City, between which places calls can at any time be made. Again, the direct distance overland between London and Baghdad is about the same as between New York and San Francisco, over which line conversations take place daily; whilst the direct distance between London and Delhi is approximately equivalent to that from Key West in Florida to New York, thence to Los Angeles in California, over which calls can be made regularly. There is, however, as Mr. Gill admits, little likelihood of the speedy and economical construction and operation of such lines as are necessary, say, between London and Stockholm, involving three or perhaps five non-interested countries, or between London and Christiania, involving perhaps eight intermediate countries, or London and Petrograd; yet there is nothing fanciful in the idea of quick communication between such places. The establishment of such systems of communication as Mr. Gill portrays naturally involves difficulties, one of the most formidable of which, we imagine, would be that of finding the requisite amount of money. Satisfactory long-distance communications such as those dealt with in the address demand the use of elaborate and costly devices, and not merely a pair of copper wires. There are in Europe, moreover, about forty self-contained local telephone operating organisations which are without standard practice or common technique of construction, maintenance and operation, with the result that the through service is poor in quality, slow and inefficient. To say the least, the present conditions in Europe in respect to long-distance telephony leave much to be desired. Developments corresponding to those which have occurred in the United States must of necessity take many years to materialise, but that is no reason why the matter should not be investigated immediately. Mr. Gill gave in his address various suggestions for grappling with the task, and a suggestion which seems to meet the immediate needs was that the telephone authorities of Europe should hold an early conference of all the telephone companies and municipalities, as well as Government Departments, to endeavour to find a solution to the problem.

Whether the address will lead to any practical developments, it is not easy to tell. In any case, Mr. Gill has put forward some interesting and important suggestions, which it is to be hoped will be properly looked into by all concerned. There is another side of the address upon which we have not touched, namely, the more technical side, dealing with modern developments which have made long-distance telephony commercially possible. But it must suffice now to mention but one of the most interesting—the so-called carrier-wave or wired wireless system, which seems to be making material progress in the United States. Although this system increases the capacity of telegraph and telephone circuits by enabling additional conversations or signals to be sent over a line by the use of high frequency currents, special precautions are necessary which lead to additional expense and render the systems only economical when speech or signals have to be transmitted over long distances. In this country there is, we believe, but one line upon which speech is transmitted on the carrier-wave principle, the line from Bristol to Paddington, with which we deal elsewhere in this issue. The fact that this line is in daily use, however, shows that British telephone engineers are, at any rate, alive to what is happening, and are ready to try ideas which seem to offer economic advantages. We trust, however, that progress in this direction may be made without the inconvenience we suffered on Monday last when a pianoforte recital interposed itself, for some unexplained reason, in a telephone conversation!

Fibre in Metals.

The association of a fibrous structure with strong and tough materials, such as wood and rope, and the corresponding association of crystalline character with weak and brittle materials, such as sugar or bismuth, has produced in the minds of many men, and even of competent engineers, the conception that all really strong and tough materials must be fibrous, and that all crystalline substances are likely to be weak and brittle. It is, accordingly, not surprising that an engineer should look for something like a fibrous structure in metals, and

particularly in steel, and, actually, his desire is gratified when he examines a fracture such as that produced by the gradual bending of any ordinary good, tough bar of mild steel. There can be no doubt at all that in such a fracture there appears signs of something that justifies the term fibrous—something very different from the hard, crystalline-looking fracture seen, for example, in a piece of not too-grey cast iron. This difference is perhaps even more strongly marked in the case of wrought iron, which develops fibrous fractures in a very characteristic manner. We have here, in fact, another example of the general fact that the view of steel held by many engineers has arisen from the fact that it made its appearance as a substitute for the older wrought iron, and that for a long time it was entirely judged by comparison with the properties of its predecessor.

Modern knowledge of metals, derived largely from the study of their micro-structure, however, throws an entirely different light on the whole question. We have, first, the unassailable fact that all metals in a normal condition—*i.e.*, when not severely cold-worked—are entirely crystalline, and that the minute crystals of which they are composed show no orientation of predominant length. There is, therefore, nothing in the nature of a "fibre" in the metal itself. The character of the fracture, however, depends upon several factors, of which we need consider only two—the manner in which the piece of metal is broken and the amount and distribution of non-metallic enclosures present in it. The same bar of wrought iron, for example, can be made to show a "fibrous" or a strikingly crystalline fracture, according as it is broken by slow bending or by a blow delivered at a point where the bar has previously been deeply notched. In the latter case, the constituent crystals of the metal have undergone little or no deformation prior to fracture. They have simply broken across their natural cleavage planes and the non-metallic "slag" present in the metal has only slightly affected the appearance of the fracture. On bending, however, the ductile iron crystals have become elongated on the tension side and their cleavage surfaces have been to some extent tilted into a direction parallel with the length of the bar. A still more powerful effect, however, comes from the slag. Actually, this is so weak and brittle that it acts almost exactly as if it represented complete discontinuities in the bar, which is thus a bundle of a number of thin bars rather than a single thick one. Each of these bars becomes elongated and broken in turn, thus producing the fibrous appearance of the fracture. In mild steel, and even in harder steels, there is always a certain amount of non-metallic impurity which becomes distributed by rolling or forging into longitudinal lines and bands. Steel fractures are as a rule less markedly laminated than those of wrought iron, but if they show a really "fibrous" appearance it is generally due to the presence of "slag" enclosures. If, however, it is suggested—as it sometimes is—that such a fibrous character is a good thing, then there is room for rather more than doubt. The individual strips or bars into which a thick bar or plate becomes more or less completely divided by the presence of "slag" bands can never be any the stronger on that account. The metal itself, in fact, possesses no real fibre; its longitudinal strength appears greater than its transverse strength only because in the transverse direction the enclosure bands make their weakening presence felt far more acutely than in the longitudinal. Were they entirely eliminated, the metal would be equally strong in all directions, and yet there would be no sign of "fibre."

It would thus seem that the desire for a "fibrous" structure is in essence a mistaken one, and that the cause of the fibrous appearance is in reality a weakness and not an advantage. It is true that under certain tests the "fibrous" material, through which layers or streaks of "slag" are disseminated, shows higher results. These are all bending tests in which the power of the metal to undergo a large amount of plastic bending constitutes the main factor. The notched bar impact test is one of these, and a "scragging" test sometimes applied to spring plates is another. Here the "fibrous" material gains a spurious advantage from the fact that it is enabled to behave very like a bundle of bars or thin plates rather than as a single piece of material. Owing to the weakness of the "slag" layers, the various rods and plates are approximately free to slide over one another, and a larger amount of bending occurs before fracture takes place. But this is no real gain for practical use, unless such use should involve the power of undergoing a large amount of cold bending once and once only. For against repeated bending under a given maximum load, this feature would be a serious cause of weakness. If, on the other hand, flexibility such as is obtainable from lamination be desired, it is surely better to employ sound steel free from internal weak layers and to laminate it consciously and by a known amount. The loose use of the word "fibrous" structure, or even fracture, must therefore be deprecated in regard to modern materials.

The Institution of Civil Engineers.

ABSTRACT OF THE PRESIDENTIAL ADDRESS OF WILLIAM HENRY MAW, LL.D., NOVEMBER 7TH, 1922.

WHEN considering the question of what should be the leading subject of my present address, I was reminded of the fact that nineteen years ago—in 1903—the Institution did me the honour of inviting me to deliver a "James Forrest" Lecture on "Some Unsolved Problems of Engineering," and it occurred to me that it might be of interest if on the present occasion I called attention to the progress which had been made towards the solution of certain of these problems and to the influence of that progress on engineering work generally. The last decade has been a very eventful one, and has exercised a most important influence on our industrial history.

There is perhaps no direction in which greater progress was made during the war period than in the investigation of the properties of constructive materials and in the evolution of what are—for all practical purposes—new materials capable of satisfying special requirements. The reasons for this are obvious. In the first place, the development of our aeronautical work gave rise to special demands for constructional materials combining lightness with strength. The improvement of our ordnance and projectiles, again, led to other demands of a special character, as did also the construction and equipment of our submarines, and altogether the war was undoubtedly directly responsible for a very important improvement of our knowledge of the properties of both our ferrous and non-ferrous metals, and most materially accelerated the distribution of that knowledge in the proper quarters.

It must be recognised by all engineers that for many years past there has been steady growth in the demands for larger and larger structures and machines. In the case of bridges there may be regarded three ways in which increases of span may be made commercially attainable, and these are: First, by improvements in the structural designs; second, by the reduction of the so-called "factors of safety" now adopted; and third, by the use of improved structural materials and constructive details. As regards the first of these alternatives there is, I think, no great chance of obtaining material aid. As regards the second alternative, the prospects are better. The allowances made under this head may be divided into two classes, first, those due to uncertainties as to the stresses to which the structures may be exposed, and, second, to uncertainties as to the qualities of the materials used and of the workmanship. These two classes of allowances are perfectly distinct in character, and have to be considered independently. Allowances of the first class are those—such as stresses due to wind pressure and changes of temperatures, &c.—which depend largely on local circumstances, and they must therefore always be matters to be decided by the individual judgment of the engineer responsible for the structure, so that a reduction in them cannot be calculated upon. Allowances of the second class, on the other hand, come under a different category. They are allowances which would not be required at all if we could be absolutely certain of the quality of all the materials used and of the soundness of the workmanship, and there appear to be good reasons for believing that under existing conditions, their amounts might be materially reduced as compared with those considered necessary even ten years ago.

During that period vast improvements have, on the one hand, been made in our steel manufacturing processes, and especially in the direction of securing uniformity of quality, while, on the other hand, the facilities for thorough testing and inspection have been enormously increased. It is thus only reasonable that advantage should be taken of these facts to decrease the allowances under consideration.

We now come to the third alternative, namely, the use of improved structural materials. There has, of course, already been great progress in this direction, but there are no indications that we have reached the limits of such progress. It must be remembered that I am speaking now of those structures, such as long span bridges, in which the weight of the structure itself forms the larger portion of the total load supported. In such structures the importance of the property of the material denoted by the term "specific tenacity" is exceedingly great, and the successful manufacture, on a commercial scale, during recent years of various high quality alloy steels has quite changed the aspect of affairs and has materially enlarged the limits of the practically permissible spans of the different types of bridges. At present the most hopeful line of progress in the development of structural materials suitable for the construction of bridges of exceptional span and for meeting other similar requirements appears to lie in the still further improvements of alloy steels and their treatment. This "treatment," whether "thermal" or "mechanical," is—as is now generally recognised—a most important matter. And here it is desirable that I should call attention to the great indebtedness of engineers for the improvements in metallic alloys of all kinds which have been rendered possible by the revelations of microscopical research. Prior to the development of microscopic analysis, for example, we knew that if we subjected a piece of steel to certain heat treatment its mechanical qualities would be altered, and although its chemical composition remained the same, the appearance of its fracture would be materially affected. But we were without definite information as to the modifications which had taken place in its molecular structure as a consequence of these transformations. Microscopic investigation, however, aided by improvements in the preparation and treatment of the samples to be examined, has entirely changed this state of affairs, and has enabled us to trace out, step by step, the changes which take place at various stages of the treatment, as well as the effect—in the case of alloys—of modifications in the proportions of the constituents. There is yet another direction in which microscopic research promises to be of value, and that is in providing us with definite information as to the changes of structure in different metals when they are injured by fatigue or are just on the point of fracture.

In speaking of the so-called "factors of safety" I have already expressed the opinion that, under existing conditions, some of the allowances at present made under this head are unnecessarily large, particularly in the case of important works in connection with which thoroughly efficient inspection of the materials used is carried out. Again, the tests available are themselves not only more varied in character than formerly, but the appliances for carrying them out have, during recent years, been vastly improved in many ways, thus rendering it possible to secure far more accurate results with much less expenditure of time and trouble. It may also be pointed out that during the last few years a most important addition to our methods of discovering defects in materials or workmanship has been placed at our disposal by the discovery of the X-rays. There are two distinct ways in which these rays can be of service, namely, first by what may be called industrial radiography, and second, by X-ray crystallography. These two methods of research are, as I have said, quite distinct in character, but they are both of practical importance.

Speaking of X-ray crystallography naturally brings to mind the valuable work recently done in connection with atomic structure and the evolution of the elements. It is not so many years since such matters were considered to be quite outside the interests of the practical users of constructive materials, but this, I am glad to say, has ceased to be the case, and there is ample reason for believing that the earnest work—and wonderful skill in devising methods of research—carried out by such investigators as J. J. Thomson, Rutherford, Soddy, Bragg, and others, will bring forth results which will have a most important influence on the practical work of the engineer.

At the time the "James Forrest" Lecture, to which I have already referred, was delivered, our old friend, the steam engine, was rather "under a cloud." In fact, a very eminent member of the Institution did not hesitate to say that it was quite open to question whether engineers would not act wisely in giving up efforts to improve the steam engine and devote their energies to the development of the internal combustion engine, which he regarded as the prime mover of the future. Fortunately, however, this view has not been generally adopted, and, as a matter of fact, the development of our steam-driven motors during the past eighteen years has been as great, if not greater, than in any similar period since the time of Watt.

When I speak of developments I do not refer solely to increases in thermal efficiency. I by no means underrate the importance of such efficiency, but at the same time I recognise that it is, to a certain extent, subservient to other qualifications. What a user of steam power desires is to obtain that power at the least possible overall cost, including not merely the expenditure on fuel, but also the outlay on attendance and maintenance, together with the interest on the amount expended in his installation of the plant and proper allowances for depreciation. In large installations such as those of our chief power-stations, important economies in labour charges have for many years past been effected by the adoption of mechanical stoking and the introduction of efficient appliances for handling coal and removing ashes, &c. Plant of this kind has been greatly improved during recent years, and the results of its use must be taken into account in considering the present status of the steam engine as compared with other classes of motive power. As regards researches bearing on the thermal efficiency of the steam engine, it is to be noted that during the last few years they have not been carried out on the old lines, but have chiefly related to the

development of the steam turbine. The first Parsons steam turbine, made in 1884, was a simple non-condensing turbine, while the first compound turbine was built in 1887, and it was not until 1892 that a condensing turbine was produced. In addition to the Parsons, various types of steam turbines have been introduced, such as the De Laval, the Curtis, the Rateau, the Zoelly, the Ljungström and others, while the growth in size of individual units has been prodigious and the increase in efficiency most important, and it seems that a thermal efficiency of 30 per cent. for a steam motor is within our reach.

The steam turbine was, at an early stage of its history, utilised by Sir Charles Parsons to drive a dynamo direct, and, as is well known, this arrangement long continued to be exclusively adopted; but the fact that while the performance of the steam turbine was improved by its being run at a high speed the efficiency of the alternators was decreased, led to the introduction of geared turbines, so that the relative speeds of the turbine and alternator could be adjusted as desired. Later, gearing was also introduced to reduce the rotational speed of the turbine to that suitable for a screw propeller, and this arrangement has been attended with remarkable developments. Employed at first to enable the propellers of moderate-sized vessels to be driven at a suitable speed by comparatively small high-speed turbines, it has been extended to larger and larger vessels in both the Navy and the mercantile marine.

In H.M.S. Hood, and in all the earlier applications of geared turbines for marine propulsion, a single reduction gear was employed, a pinion on the turbine shaft gearing into a wheel on the screw shaft; but a desire to utilise to the full the benefit of high speeds for the turbine led to the employment of double reduction gear, and a very large number of such installations are now in use. Unfortunately, the results have, in quite an important number of cases, proved to be unsatisfactory, and the question of how to prevent the defects which have occurred forms probably the most important problem which has demanded the attention of mechanical engineers for many years past.

Turning now to steam engines of the reciprocating type, it cannot be said that any very striking developments have taken place during the past few years; but this statement is not to be taken as asserting that no progress has been made in their design or construction. This is far from being the case. Like other classes of machinery, they have benefited by the availability of a wide range of constructive materials of an improved quality and by the great progress which has been made in the design and construction of machine tools. On the whole, perhaps the most prominent features of ordinary steam engine practice in recent years have been the steady increase in the use of superheated steam and the improvements in connection with the condensers and air pumps. As regards steam raising, whether for use in turbines or reciprocating engines, the most striking feature has been the steady increase in the use of water-tube boilers and the great development of the use of oil fuel instead of coal for marine purposes.

Although, as I have said, internal combustion engines have not succeeded in supplanting the steam engine, their use during recent years has increased enormously in a great variety of ways and directions. Engines of this kind, of small or moderate powers, are now being turned out at the rate of many thousands per day and are finding an endless number of fields of usefulness. Our motor cars and our aeroplanes are practically dependent on them, while their good service in connection with our submarines and high-speed coastal boats is well known.

There are a very large number of other directions in which advances have been made in recent years—all tending to extend the powers of the engineer; but with most of these it is impossible to deal in any way on the present occasion, while others I can only briefly mention. Amongst the latter, relating chiefly to mechanical engineering, may be included the great development of grinding machines which enable extreme accuracy of workmanship to be attained with very moderate expenditure, the introduction of electric and oxy-acetylene cutting and welding processes and the further improvements in steel for high-speed cutting tools; while the civil engineer has been benefited by the production of excavating and tunnelling machines, mechanical appliances for the construction, repair, and maintenance of roads, dredging plant, and pumping machinery, all having powers of output scarcely imagined a few years ago and all tending to reduce cost. It will, I think, be evident from the facts I have put before you that, in spite of the disturbances caused by the war, recent years have, so far as engineering knowledge and practice are concerned, been years of most substantial progress from both the theoretical and practical points of view.

In considering the researches which have been carried out and the advances which have been made in recent years, there is one fact which appears to me to be of far greater importance than all others. It is this: in none of the researches referred to, varied and extensive as they have been, is there the slightest trace of finality. Much as has been discovered and great as has been the progress made, it is most certain that we have at present only effected the preliminary opening up of the mine of knowledge, and that the real wealth of its contents is as yet unknown to us. So far as we have gone, we can only say that the "impossible" of yesterday has become the "possible" of to-day, and in the early future many of these "possibilities" bid fair to become accomplished facts. Surely this is a great inheritance, which should incite our coming generations of engineers to make most strenuous efforts to secure greater—and still greater—developments, so that they may, in their turn, leave behind them a heritage more glorious still.

Irish Railways.

The future of the railways of Ireland is again in the melting-pot. The labour troubles of the companies since Government control ceased on August 15th, 1921, led to a threatened strike, which was avoided by the appointment of an arbitrator, whose award, however, was not acceptable to the men. This failure led, in turn, to the appointment by the Provisional Government of a Commission to report as to (1) the present position of Irish railways; (2) the best method of administration in the interests of the shareholders, the employees and the public; and (3) the relations between the railway workers and the companies. The report of this Commission was dated August 9th last, but, whilst the conclusions were made public soon after, the document itself has only just been published. Before reviewing it, it may be noted that in Ireland there are forty-six different companies, of which no less than twenty-eight are working companies. They possess nearly 3500 route miles, and, in view of Ireland's divided Government, it may be of interest to know that 418 miles belong to companies wholly in the six-county area and 355 miles belong to companies—for example, the Great Northern—partly in the six-county and partly in the twenty-six-county area.

The disadvantages of such a small mileage of railway being divided among so large a number of companies has always been recognised. The Allport Commission of 1885–1888 proposed centralisation in the hands of one company and the minority of the Scotter Commission of 1906–1910 made a similar recommendation. The majority of the latter body proposed that the railways be purchased and worked by the State. The present proposal is that the railways shall be purchased by the Government, which shall give in exchange railway bonds and not cash, but that the management shall not be directly under a State Minister. There shall be a National Railway Board of eight members, one of whom shall be a railway expert of wide managerial experience. Industry and trade shall have four representatives—of whom two shall be nominated by the Council of Agriculture. Labour shall have two; and the Irish Treasury one. It is hoped to secure happier relations with the men by the appointment of local sectional conciliation boards, above which shall be a general railway council, and, failing agreement at the latter, a general conciliation board of twelve members—four from the management, four from the railwaymen's unions, and four from the users of the railways. The Commissioners remark: "While we ground our opinion in favour of State ownership upon the results that we would expect from the changed policy that would follow from the substitution for boards of directors, concerned with the payment of dividends, of a body having the public welfare always in view, yet there are other advantages which should not be left out of account. These advantages, which any system of unification would bring about, are:—(1) The remodelling and diminution of the supervisory staff, including the directorate; (2) the co-ordination of services; (3) the construction and standardisation of engines, wagons, coaches and rolling stock; and (4) the purchasing of stores in bulk." It is added that under any unified system the building of rolling stock in Ireland could, consistently with economy and getting the best value for the money, be greatly developed.

The Irish railways fall into a category of their own. All the principal manufacturing industries are on the seaboard, consequently the haulage of raw material is inconsiderable. For the same reason, the population is also clustered near the sea, and of forty-three cities and towns, twenty-three, with a total population of one million souls, are on the sea or on navigable rivers, whilst the other twenty similarly sized towns are inland and have a population of only 160,000. Labour on the Irish railways, as in almost every other industry, was in the pre-war period underpaid—in some of the lower grades, miserably underpaid. The report observes as to this that "it is not easy for any of us to cast a stone at the railway management, for the underpayment of Irish labour in those days was general; the conscience of the community suffered it, and the bulk of the community took profit by it." The average wages of railway porters was 15s. or 16s. a week, and of platelayers from 14s. to 17s. When, however, the Government conceded the eight hours' day and standardisation of wages and conditions in the spring of 1919, these terms were made to apply also to the Irish railways, and when control ceased in August, 1921, the lowest wages paid in Ireland to any porter or platelayer were 53s. 6d., and the lowest salary paid to a clerk was £80 a year. The ratio of post-war to pre-war wages was as three to one, and there was a substantial increase in materials, coal, stores, &c. On the other hand, rates had been increased to a proportion of about two to one, and the companies assert that they will be entirely unable to carry on unless there be a great reduction in wages and considerable alteration in the conditions of service. A point that is exceptional, when comparing Ireland with England, is that there are nearly 500 miles of railway for which the Government or local authorities are guarantors. Many of these lines have always been run at a loss, and it is said of one of them that the guarantee now means over 9s. in the pound.

The present Commission thinks it right to point out that the Irish railways are directed and managed by Irishmen, and that, viewed as private concerns, they are, broadly speaking, not ill-managed. The railway companies' policy has been inevitable, and as long as the railways are privately owned this will continue. But good management from a shareholder's point of view may not be the best management for the country. In a State-owned railway, where a trader suffered by his railway route being more costly than his foreign competitor's longer route by sea, serious consideration would have to be given, says the report, to the question whether a low local Irish rate could not be provided to meet each such case," such rate being, of course, in effect a subsidy." A point that will appeal to all lovers of Ireland is that she is, we all hope, about to enter upon a new career, in which it is safe to anticipate that every effort will be made to develop her resources. The Commission is very emphatic on the question that there are powerful general objections to a system in which State management is combined with State ownership. This combination, it is said, places the railways at the mercy of local, sectional or political pressure. As the railways will be managed by a Board and not by the State, and, moreover, payment for them will be made by railway bonds and not by cash, there will remain the incentive that is found in private management and in the personal interest. It should be added that one member of the four on the Commission presented a minority report, which protested against such a financial expenditure in these times, and recommended the unification of all the railways for a period of three years, during which the Government shall guarantee the dividends paid in 1921.

LOCOMOTIVE CUT-OFF AND HORSE-POWER.

Selection of the proper cut-off or the proper positions of the reversing lever required at various speeds for the development of maximum horse-power or draw-bar pull is one of the most important factors in locomotive operation, but has received insufficient attention. For any one speed there is only one cut-off at which the engine will deliver its maximum in either horse-power or draw-bar pull. But how do the drivers actually select various lever positions for various speeds, or how have they been taught to select them when maximum power or pull is desired or required? Such a situation may occur when the engine is failing to keep the necessary time. On the New York Central Railroad tests have been made and charts prepared showing the draw-bar pulls for a wide range of cut-off for definite types of engines. This information is tabulated on small pocket cards issued to the enginemen. This card shows for, say, three types of engines the speed, the corresponding cut-off, and the corresponding notch on the quadrant of the reversing lever. Where a screw reversing gear is used the number of revolutions of the hand wheel are given, counted from the start at full forward position. Thus for a certain class of engine a speed of 18 to 20 miles per hour requires a 70 per cent. cut-off, which is given with the lever in notch No. 17. Similarly, another class of engine at 55 to 60 miles an hour requires a cut-off of 46.5 per cent., which is obtained by six revolutions of the hand wheel. On the back of the card are instructions how to ascertain the speed, together with the cylinder and driver dimensions of the classes of engines listed on the face of the card. The men are instructed to use the full throttle or regulator until reaching the shortest cut-off at which the engine will run smoothly, after which the engine is to be "throttled" as necessary to meet speed requirements.

Australasian Engineering Notes.

Professor A. J. Gibson, of Sydney, has conducted an investigation into the Brisbane water supply, and has recommended the laying of a 15in. reinforced concrete pipe connecting Gold Creek Reservoir with Enoggora and the installation of duplicate electrically driven centrifugal pumps, each capable of delivering 2250 gallons per minute against a head of 120ft., at an estimated cost of £22,000. Professor Gibson has also recommended the installation of two 9,000,000 daily capacity pumping plants. Mr. J. Peart, the engineer to the Water Supply Board, contends that instead of 9,000,000-gallon pumps, three units capable of delivering 6,000,000 gallons per day should be installed as soon as possible.

* * * * * *

Interesting figures with regard to the current prices of steel and iron were revealed recently by the sales manager of the Broken Hill steel works, when giving evidence before the New South Wales Wages Tribunal. The manager said that the actual quotation for pig iron was £7 7s. 4d. c.i.f. and e. duty paid Melbourne. Other prices were:—Steel billets, £14 3s.; structural steel, £13 10s. 6d.; merchant bars, £13 12s. 6d.; light rails (14 lb.), £12 12s.; 20 lb. rails, £13; heavy rails (over 45 lb.), £10 19s. 9d. He added that war scrap was being sold in Australia to-day as a substitute for pig iron.

New Baltic Tank Locomotives.

We described, illustrated, in our issue of June 16th last the new "Baltic" tank engines designed by Mr. Robert Whitelegg for dealing with the heavy, fast, and ever-growing traffic to the several popular seaside resorts on the Ayrshire coast of the Glasgow and South-Western Company's system. The engines, six in number, 540 to 545 inclusive, were constructed by the North British Locomotive Company, Limited, Hyde Park Works, Glasgow, and, as will be seen from the drawing we give as a Supplement to-day, they are of very large dimensions and power; in fact, the aim of the designer has been to incorporate all the best features of the company's existing tender engines with the advantages of a double-ended tank engine wherein the weight of fuel and water is all available for increasing the adhesive weight and hence the tractive effort. They are fitted with a Robinson superheater of twenty-one elements, with circulating device and header discharge valve, and work up to a superheat of 650 deg. Fah. The valve motion is of the Walschaerts type with the connecting-rods, fitted with Skefko ball bearings, operating piston valves made under the patent of Allen and Simmonds, Limited, of Reading, and fitted with Robinson's pressure relief valve. Reversal is effected by a steam reverser. To effect the handy manipulation of the engine when running either backward or forward, all the operating levers, namely, regulator, vacuum brake valve, whistle, and sand gear, have duplicate handles on either side of the footplate. An automatic ash ejector is fitted in the smoke-box. To avoid trouble with paint, Mr. Whitelegg has clothed the boilers with blue planished steel, which is very easily kept clean.

These engines have only been at work a few months, but are working most successfully and quite justify the advent of this type into Scotland. Their capabilities, so far as quick starting, acceleration, and high-speed running, and with all the facility with which they handle very heavy trains, are very marked.

It should be noted that these "Baltic" type engines were designed chiefly for dealing with the fast and ever-growing heavy passenger traffic between Glasgow and the popular coast resorts served by the Glasgow and South-Western Railway, viz., Troon, Prestwick, Ayr, Girvan, Ardrossan, Largs and Fairlie, and the whole of the batch has been regularly engaged on these services since they were delivered from the builders, and have acquitted themselves admirably and fully justified the selection of the type by Mr. Whitelegg, who, it might be added, was the originator of this form of heavy and powerful express locomotive in Great Britain, having designed some for the Tilbury section of the Midland Railway in 1912.

On a test trip the following train loads were handled :—

	Tons.
Glasgow to Kilmarnock	225
Kilmarnock to Dumfries	255
Dumfries to Carlisle	335
Carlisle to Dumfries	335
Dumfries to Kilmarnock	240
Kilmarnock to Glasgow	270

These latest engines on the Glasgow and South-Western Railway rank as the first of the type in Scotland, and about the most powerful tank locomotive in Great Britain. Full particulars were given in our issue of June 16th last, but we may recall here that the cylinders are 22in. diameter by 26in. stroke, that the coupled wheels are 6ft. in diameter, and that the working pressure is 180 lb., giving a tractive effort at 85 per cent. boiler pressure of 26,740 lb. The total weight is over 99 tons.

French Production of Cast Iron.

During the first six months of 1922 the production of cast iron in France, according to information compiled by the Comité des Forges, amounted to 2,294,895 tons, compared with 1,800,424 and 1,616,529 tons during the first and second halves of 1921. There was thus an increase in production of 27.4 per cent. compared with the corresponding period of last year, and of 42 per cent. compared with the last six months of 1921. Compared with the results obtained by the same furnaces during the last normal year before the war, the average production for the first six months of 1922 represented an output of 50.5 per cent.

The number of blast-furnaces working on July 1st of this year was ninety-two, as against seventy-three on January 1st. Eighteen resumed work in the Eastern Basin and in Lorraine and one in the West; other centres remained stationary. There was only a difference of one in number between the blast-furnaces working on July 1st this year and on January 1st, 1921. The Central and Southern Basins have been unable again to put in action the furnaces which had to shut down during the economic crisis at the beginning of 1921; on the other hand, among the group of furnaces in the East and Lorraine, a greater number are working than was the case eighteen months ago. Thus the improved conditions shown by recent figures have as yet only benefited the Eastern metallurgic basin.

The Eastern and Lorraine groups between them produced 1,892,000 tons during the first six months of 1922, *i.e.*, 159,000 tons, or 37.7 per cent. more than were produced in the first six months of 1921. During the first half of 1922 and the whole of 1921 these two groups furnished in the first case 76.3 per cent., and in the second case 79.7 per cent. of the total national production, and it is estimated that they are now furnishing 82.5 per cent. The Western region, the production of which has increased by 14,000 tons, comes far behind them with a total of 165,000 tons (7.2 per cent. of the total production); production in other basins has decreased.

Of the total 2,294,895 tons produced during the first six months of 1922, 2,260,000 tons were furnished by blast-furnaces and 34,895 tons by electric furnaces; the last amount shows an increase of 2000 tons compared with the first six months of 1921.

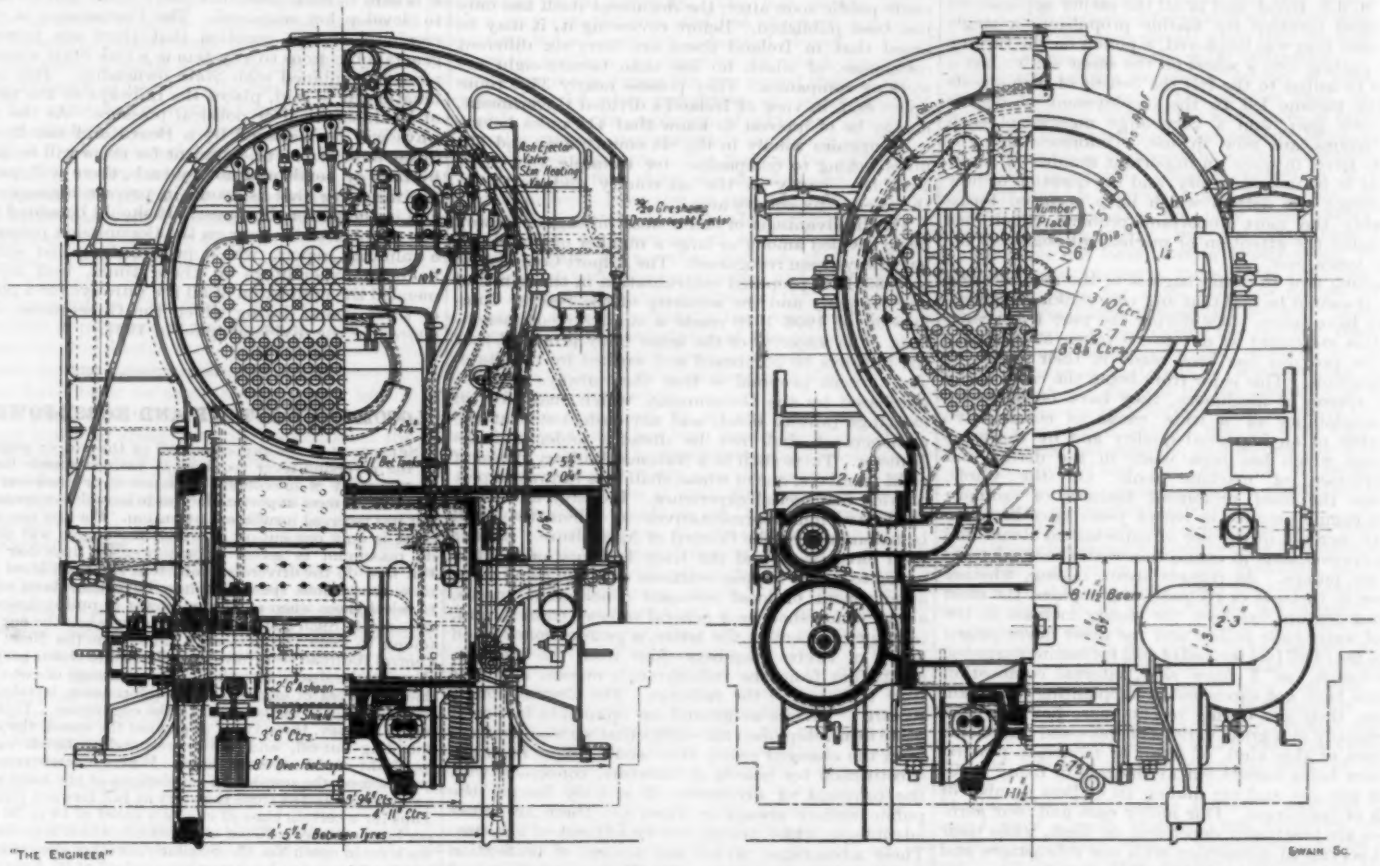
Investigations carried out by the Department of Drainage, Minnesota, on the effects of alkali soils on drain tiles suggest that the trouble with their failure arises not through disintegration beginning at the interior surfaces of the wall of the tile through the action of the water carried by the drain, but by extreme conditions of the soil in direct contact with the outer surface of the tile wall. The danger limit of total salts for such waters is about 3000 parts per million when the salts consist almost wholly of the sulphates of magnesium, sodium and calcium, with the first two of these running nearly two-thirds or three-fourths of the total. The most pronounced failures in Minnesota have occurred where the total salt content of the soil has exceeded 4500 parts per million. While the tile behaved most badly in cases in which the soil water was richest in total salts, the conclusion reached by the investigators was that the sulphates were in a large measure directly responsible for the failures.

Developments in Radio Telegraphy and Telephony.

On Friday evening of last week Mr. E. H. Shaughnessy, who is head of the wireless section of the General Post Office, delivered a lecture on the above subject at the Regent-street Polytechnic. By permission of the Postmaster-General, and with the co-operation of the Marconi and broadcasting companies, the lecture was followed by a demonstration of wireless telephony not hitherto attempted in this country. At 7 p.m., Sir William Noble, of the Broadcasting Committee, introduced, by wireless telephony, the Lord Mayor of Bristol, who subsequently addressed the audience from his residence in Bristol over the wired wireless system to Paddington. The speech of the Lord Mayor was transmitted from Paddington to Marconi House by wire, and then broadcasted by means of electro-magnetic waves. Every member of the audience at the Polytechnic was provided with a pair of head telephones, by means of which the Lord Mayor of Bristol's speech and a subsequent speech delivered by the Lord Mayor of London at the Guildhall were clearly heard, but a loud-speaking receiver which was set to work in the lecture room behaved anything but satisfactorily. Loud-speaking receivers are, unfortunately, often far from good reproducers of speech, and it is rather a pity, we think, that they are used for demonstration purposes. However, the bad reproduction was in no way due to any fault of Mr. Shaughnessy or others who were responsible for the demonstration. As far as the transmission was concerned everything worked well, and both the speeches referred to and an instrumental and vocal concert afterwards broadcasted from Marconi House were faithfully reproduced on the head telephones.

In his lecture, Mr. Shaughnessy dealt with the development of wireless work from the time of its inception. Clerke Maxwell, he explained, predicted that electro-magnetic waves had the same characteristics as light waves—the same velocity, &c. Later, Hertz carried out experiments with a spark oscillator, by means of which he produced very short waves, and demonstrated the presence of those waves by means of loops of wires at some little distance from the oscillating source. That was the beginning of wireless work, but little progress was made until the introduction of more sensitive receivers. Marconi invented his coherer in 1897, and spark telegraphy was then made possible. After referring to the quenched spark transmitter and to the fact that wireless communication now enables newspapers to be published on ships, the lecturer went on to explain the difference between the various kinds of waves, such as continuous waves, damped waves and interrupted continuous waves. One of the advantages of continuous waves over waves produced by sparks was that they enabled the aerial to be used the whole of the time, and continuous waves also gave very good results.

The first continuous wave generator was the Duddell arc, but Duddell's generator was unsuitable for wireless work. Poulson, however, introduced certain improvements, such as that of enclosing the arc in a gas-filled chamber, and those improvements made the arc generator suitable for wireless communication. With a picture of the interior of the Leafield station on the screen, Mr. Shaughnessy explained that that station was a good example of a modern arc station. The height of the aerial masts was 300ft., and as much as 240 ampères of high-frequency current was put into the aerial. One of the difficulties with which they had to overcome at Leafield



GLASGOW AND SOUTH-WESTERN RAILWAY—HALF CROSS SECTIONS AND FRONT VIEW OF BALTIC TANK LOCOMOTIVE

was that of preventing the high-frequency oscillations circuiting back into the generators, but the means which had been adopted had proved quite successful. Another picture which was thrown upon the screen showed a 1000-kilowatt arc equipment designed by American engineers. The weight of metal used in the construction of that equipment, the lecturer explained, was 70 tons, but he doubted whether so much metal was really necessary. The timed-spark wireless generator invented by Marconi was a really wonderful device, for with the aid of a rotating disc it gave off sparks at definite intervals in respect of the previous spark, and energy was delivered to the aerial in exact step with that which was already there. The timed spark generator was still used in certain cases, but the thermionic valve was making headway as a generator of electro-magnetic waves.

The development of the thermionic valve began with the invention of Dr. Fleming's two-electrode valve, which was patented in 1904, and which was used as a wireless detector. Later, Dr. Lee de Forest introduced a third electrode, which ultimately resulted in the valve becoming an invaluable piece of apparatus. There was little doubt, however, that Forest did not realise at the time the importance of his idea. After describing the principles upon which valves operated when used for detecting, amplifying and transmitting, the lecturer went on to deal with developments in valve manufacture, and explained that silica valves were made for dealing with 10 kilowatts, whilst in America special water-cooled valves had been developed for much larger powers. There was every prospect, he thought, of the valve being used extensively for the generation of high-frequency oscillations.

Unfortunately, owing to the lecture being commenced at little later than was intended, and perhaps also on account of the wireless demonstration being started sooner than the lecturer expected, Mr. Shaughnessy was unable to deal with the wired wireless system between Bristol and Paddington as he originally intended. As it was, his lecture was brought to an abrupt end by Sir William Noble introducing the Mayor of Bristol by wireless, which naturally resulted in all the telephone receivers being brought into action and the lecture coming to an end. Mr. Shaughnessy has, however, kindly supplied us with a diagram of the connections for the Bristol to Paddington scheme, which is quite simple and straightforward. "Wired wireless" telephony is another name for the carrier wave system, in which high frequency oscillations of desired frequencies are sent into a telephone or telegraph circuit, and the circuit is then capable of dealing with speech of signals in addition to acting as an ordinary telephone or telegraphy circuit, and without interfering with the ordinary communications. The system is dealt with in Mr. Frank Gill's address which we publish elsewhere in this issue, and although the American multi-frequency systems there described differ in some respects from that which is being used by the British Post Office on the line from Bristol to Paddington, the basic principle is the same. The high-frequency currents, which are sent through the wire at the desired frequencies, are generated by the same kind of generators that are used in wireless work, such as valves which are also used for receiving purposes, and the carrier wave is modulated by the speech currents. On a line between Chicago and Omaha, described by Mr. Gill, no fewer than twenty-seven telephone and telegraph circuits are operated on four wires, twenty of them being two-way carrier telegraph circuits. The systems which Mr. Gill describes, however, involve the use of filters, which are not used on the Bristol to Paddington line. At present there are in the United States 4776 route miles or 16,576 channel miles of carrier telephone circuits, the corresponding figures for carrier telegraphy being 10,919 and 78,870 miles respectively.

The Bristol to Paddington line, which is entirely overhead, is in regular operation for ordinary commercial service, and acts without any disturbance to or from ordinary trunk conversations. Speech is transmitted over an ordinary pair of lines from the exchange to the low-frequency bridge shown in the top left-hand corner of the diagram. The bridge is arranged to prevent current passing to the receiving side of the apparatus shown in the lower part of the diagram, where it will be seen that the bridge is connected to the anode side of the low-frequency amplifier, but the speech current is permitted to pass to the primary side of the transformer, which is connected to the grid circuit of the control valve. This valve, it will be perceived, is connected in parallel with the high-frequency oscillating valve, both valves being fed by a single high-tension battery through a steadying choke. The speech currents fluctuate the grid potential of the control valve, and these fluctuations alter the anode filament resistance of the valve, thus providing a fluctuating resistance path for the feed current, which is kept steady by the choke. The high-frequency oscillating valve is thus robbed of energy, and the amplitude of the high-frequency oscillations which are sent into the line is varied in direct proportion to the low-frequency fluctuations of the grid potential of the control valve caused by the speech currents. The frequencies used on the line for the outward and return conversations are 16,000 and 21,000, and the receiving apparatus is tuned to these frequencies.

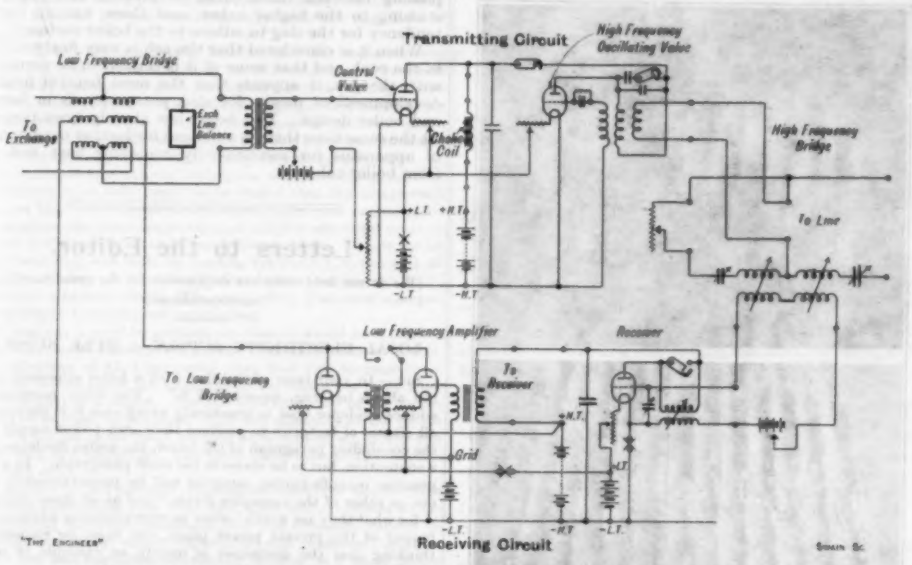


DIAGRAM OF CONNECSIONS OF THE BRISTOL TO PADDINGTON "WIRED WIRELESS" SCHEME

The United States Super-power Survey.

EARLY in 1920 William Spencer Murray, who had previously been in charge of the electrification of the New York, New Haven and Hartford Railroad, read a paper before the American Institute of Electrical Engineers, in which he urged the creation of a super-power system for the north-east Atlantic seaboard; and at that time he estimated that a wider use of electricity within the proposed area would bring about an annual economy in power cost and operation of 300,000,000 dollars, and reduce incidentally the consumption of coal by 30,000,000 tons.

The proposition followed right on the heels of a war-time experience which had brought to light the fact that the region in question was inadequately supplied with power equipment; and governmental inquiry, under pressure of strife, had revealed a disquieting state of affairs and a pretty general wastefulness of coal in steam power plants. In these circumstances, Mr. Murray's paper aroused instant favourable response on the part of the four great engineering societies, and with their endorsement the scheme was laid before the authorities in Washington, where the Congress shortly afterwards appropriated 100,000 dollars for the purpose of making a so-called super-power survey. The work was carried out under the supervision of the United States Geological Survey and under the direct control of Mr. Murray. The report appeared towards the end of last year, but in view of its general interest, a summary of it will still be welcome to our readers. The super-power zone embraces that geographical division of the United States lying between the 44th and 39th parallels of latitude, and reaching inland on an average for approximately 150 miles. Within this region is concentrated one-fourth of the population of the United States, and the factories and mills there produce in value 40 per cent. of all of the manufactured commodities turned out by the entire nation. Operated within this zone, and for the most part independently, are 315 electric public utility companies, eighteen trunk line or heavy traffic railways, and an aggregation of 76,000 industrial establishments which require mechanical energy for their running. The purpose of the survey was to determine how the consumption of coal in this zone could be reduced, and how at the same time the transportation of fuel could be lessened; how industry could be speeded up; and, finally, how the hundreds of existing public electric companies could be linked for the general weal, and how certain super-power stations could be established where electricity could be generated at a minimum of cost and at a maximum of efficiency for the purpose of accommodating the base load of the whole zone.

Broadly speaking, the survey dealt particularly with the needs of the public electric companies, the heavy traction railways, and the manufacturing industries; and the report considers what may be achieved by 1930 by the adoption of a super-power system for the territory under discussion. Based on the 1919 rates of power production, as against those that would be in effect in the super-power system, and applying the figures to the load that is likely to exist in 1930, the following annual coal savings are predicted:—

	Net tons.
Public electric companies	19,149,000
Heavy traction railways	10,210,000
Manufacturing industries	20,625,000
Total saving in 1930	49,984,000

At the present time, the total demand for electric current within the projected super-power zone does not exceed 11,000,000,000 kilowatt-hours annually, but at the normal rate of expansion there will be needed by 1930 an aggregate generating installation capable of furnishing in the course of a year a total of 31,000,000,000 kilowatt-hours; and if this energy be supplied agreeably to the plan suggested by the super-power survey report, then it will be feasible to effect each twelvemonth, by 1930, a saving of 511,000,000 dollars. That can be accomplished at a combined outlay of about 1,500,000,000 dollars.

ELECTRIFICATION OF RAILWAYS.

Within the super-power zone are operated 36,000 miles of track, including main lines, yards and sidings, and of this trackage we are assured that the density of traffic is ample to warrant the electrification of 19,000 miles. It is estimated that electrification would result in savings in fuel, maintenance of equipment and in crew wages amounting to 82,000,000 dollars yearly. The capital expenditure needful to achieve this would be 570,000,000 dollars. The idea is that the electrified lines would buy the necessary energising current from the public electric companies forming part of the super-power system, and that the roads would therefore limit their outlays only to electrification costs and to the purchase of locomotives and of multiple-unit coaches for passenger service.

INDUSTRIAL POWER.

Regarding the industrial power situation within the zone, the Survey states that had there been a maximum use of purchased power in 1919 there would have been a saving in coal of 13,502,100 tons by the adoption of the super-power system of co-ordinated central stations. Inquiry revealed that in 1919 the equivalent of 9,311,440,000 kilowatt-hours was developed by prime movers individual to thousands of industrial establishments. The energy purchased amounted to 3,338,800,000 kilowatt-hours—a little more than a third of the total block of energy required. It seems, according to the report, that 4,008,200 horse-power of prime movers might have been shut down to advantage and current bought to the extent of 5,623,800,000 kilowatt-hours, which would have made a total of 8,962,600,000 kilowatt-hours of purchased power in 1919. That would have effected a saving of 71 per cent. of the coal used for industrial purposes within the region in question.

In general, it was found by the Survey investigators that it would be economically practicable for all industrial establishments requiring 500 horse-power or less to buy their energy. It is only when the demand is about 500 horse-power, and associated with some special needs for heat, that the generation of power by an isolated plant can be justified, and even then it is urged that central station connections should exist for the purpose of providing against irregularities of load. The efficiency of power production by isolated plants is limited in the way of any considerable improvement by the necessarily small amount of capacity involved.

CO-ORDINATION.

The most important phase of the whole problem is the co-ordinating and interlinking of existing electric public utility plants and the creation of especially large super-power base-load stations, both steam-driven and hydraulic. At present, the public electric companies operate 558 plants, and for the most part the 315 companies concerned act independently and without means of interconnection. The total number of power stations that would be needed to supply the entire zone in 1930 would be 273, of which 218 would belong to existing electric enterprises. The other power stations would be base-load plants, and the steam-electric installations would range individually in capacities from 60,000 to 300,000 kilowatts. In none of these establishments would be placed a turbo-generator of less than 30,000-kilowatt capacity. Too much emphasis cannot be laid upon the fact that the super-power system is not designed to invade the entity and the franchise rights of existing electric companies. Its purpose is exactly the reverse. Recognising the great economies already brought about through these agencies, the aim is to encourage these enterprises and to help them to accomplish even better results through co-operation. In short, the super-power system contemplates the institution of a series of load centres, at which points power may be created at lower costs than those obtainable under the present *régime* of unassociated power production and distribution. At these load centres, situated where economy dictates, capacity so provided would be paralleled with existing electric utility capacity and dispatched by the companies over their transmission or distribution systems to the consumers, as is the practice to-day.

In 1919, the electric public utility load was approximately 10,000,000,000 kilowatt-hours, and there is ample reason to believe that the load will reach 26,000,000,000 kilowatt-hours in 1930. The annual growth for the past decade has been at the rate of 11 per cent., and the foregoing figure is obtained by assuming the increment up to 1930 to be at the rate of only 9 per cent. per annum. The difference in cost between power production by large and by small units is very great. For instance, the production costs for plants of 100,000-kilowatt capacity and upward, as compared with those of 1000 kilowatts and less, vary 3 to 1 in favour of the big station in the matter of fuel and 4 to 1 to the advantage of the larger plant in the factors of maintenance and supplies.

An examination of the performances in 1919 of 400 steam-electric plants showed that the fuel rate of the electric companies averaged 2.73 lb. per kilowatt-hour, with a heat utilisation of 35,800 B.Th.U. per kilowatt-hour. In contrast with this figure, we are informed that the proposed base-load steam-electric plants of the super-power system, when operating at the same annual capacity factor, would burn only 1.41 lb. of coal per kilowatt-hour, and would show a heat utilisation of 18,300 B.Th.U. It seems that for independent operation of the steam-electric companies, as in 1919, the generating capacity required was 46 per cent. greater than the annual peak load, thus giving a resulting capacity factor of 26 per cent. On the contrary, by the super-power system, in 1930, through the best use of joint reserve machinery, the generating capacity required would be only 9 per cent. in excess of the annual peak load, and it is claimed that the annual capacity factor would be raised to 45 per cent.

The steam-electric plants of the public utility companies,

which would be retained and become part of the super-power system, would be able to turn out a kilowatt-hour on an average coal consumption of 2.5 lb., as against 2.73 lb. per kilowatt-hour for all of the electric utility steam plants in the zone to-day, the comparison being made upon an equal-capacity-factor basis. The average size of the steam-electric plants that would be retained is 44,600 kilowatts, representing a reproduction cost of 124 dollars per kilowatt, while the new steam-electric plants, projected for the system by 1930, would entail an outlay of 109.50 dollars per kilowatt-hour.

PLANT FOR POWER STATION.

Upon the subject of the type of the new plants, the reports says that after consulting with many authorities representing manufacturers throughout the entire country, as well as with designing and operating engineers, the following characteristics for base-load steam-electric plants were decided upon:—Steam pressure at turbine throttle, 300 lb. per square inch; superheat at turbine throttle, 230 deg. Fah.; final temperature at turbine throttle, 652 deg. Fah.

The base-load steam-electric plants would be built up on multiples of 30,000 kilowatts—360,000 kilowatts being the largest installation recommended for the system. These plants would be constructed on an extension basis, some of them requiring ten years for their expansion to complete size. By 1930 these stations should operate at about 62 per cent. capacity factor. The unit cost of a base-load station would vary but little with size after a 120,000-kilowatt installation had been reached. The unit investment cost for a 360,000-kilowatt station, in comparison with the former, showing a reduction of only 6.5 per cent. On the contrary, the unit investment cost for plants of less than 120,000 kilowatts is marked by an increase of 23 per cent., comparing a 30,000-kilowatt station with one of 100,000-kilowatt capacity.

According to the estimates in the report, fourteen new steam-electric plants, aggregating 2,520,000 kilowatts, would be required by 1925, and eighteen new steam-electric plants, aggregating 3,930,000 kilowatts, would be needed by 1930. A number of the great base-load stations would be erected in the anthracite region of Pennsylvania, and therefore either at or close to mine mouth. They would use No. 3 buckwheat coal, and because of the diversity factor they could be operated at 75 per cent. of their capacity. By 1930 electrical energy could thus be produced, inclusive of fixed charges, at 5.7 mills per kilowatt-hour. That would be at a sufficiently low figure to permit an additional fixed charge for transmission on that portion of the power which would be sent to the tributary tide-water section of the zone.

WATER POWER.

While, from the very nature of things, the super-power zone must in the main depend upon fuel for the generation of most of its energy, still the plan contemplates the fullest utilisation of water-power resources, both within the zone and outside of it, but in economical transmission distance. Apropos of this, the experts of the Survey declare that current at 220,000 volts can be sent over the wires 350 miles with a loss of less than 6 per cent. By 1930, agreeably to the super-power plan, it is proposed to develop the resources of five rivers to the following extent:—

River.	Capacity, kw.	Output, millions of kw.-h.	Investment, thousands of dollars.	Production cost mills per kw.-h.
Potomac ..	200,000 ..	950 ..	22,000 ..	3.36
Susquehanna	185,000 ..	1230 ..	28,000 ..	3.22
Delaware ..	350,000 ..	1250 ..	51,500 ..	5.95
Hudson ..	150,000 ..	900 ..	38,350 ..	5.84
Connecticut	165,000 ..	750 ..	28,000 ..	5.45

The new hydro-electric developments, which should be made by 1930, will bring the total hydro-electric capacity up to 1,050,000 kilowatts, of which the old plants would constitute 43 per cent. In 1930, the total hydro investment would amount to 245,977,000 dollars, of which the old plants would then represent 35 per cent. Nine years hence, the water-power developments in their entirety, if the super-power scheme be carried out, would meet 21 per cent. of all of the power needs of the zone, the remaining 79 per cent. would be taken care of by steam-electric installations.

Within transmission distance of the zone are the water-power resources of the Niagara and the St. Lawrence rivers, and they will undoubtedly feed into the super-power system eventually. In 1930 the super-power transmission system should consist of 970 circuit miles of 220,000-volt lines, and 4696 circuit miles of 110,000-volt interconnecting lines. To these lines would be linked, by 1930, quite 5,600,000 kilovolt-ampères of transformer capacity, not including the transformer capacity in the base-load steam-electric plants. When the transmission systems for the St. Lawrence and the Niagara developments are constructed, they would add 3140 circuit miles of 220,000-volt lines and 1,824,000 kilovolt-ampères of transformer capacity. Potentials of not less than 220,000 volts have been chosen to transmit power from plants which are at a considerable distance from the general interconnected super-power zone system, and within the zone not less than 110,000 volts would be employed for interconnection between power and load centres.

It is authoritatively stated in the report "that with few exceptions, under present conditions, coal must be used in raw form to produce cheap power. By-products are essential in time of war, regardless of cost, and it has been deemed desirable to provide space for processing plants in the selection of sites for super-power stations. The general encouragement regarding process fuel lies along the line of converting raw fuel entirely into gas for consumption under the boilers of the steam-electric stations, thus eliminating the disadvantages of coke concentration. Under such procedure, a process plant, used in connection with a steam-electric plant, may produce power at a materially lower cost than that from raw coal. The extent of practice, however, is not sufficient to permit a stronger statement than that development along this line is exceedingly encouraging."

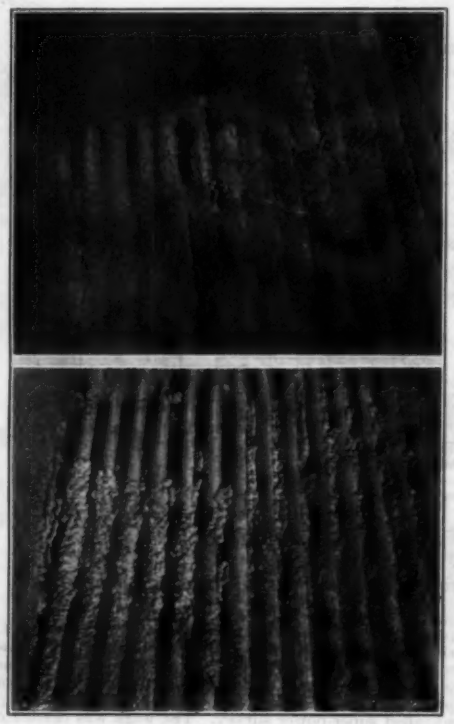
Mr. Murray, in touching upon the electrification of railways and the possible use of direct and alternating-current systems, makes this significant statement: "Although the magnitude of the zone will permit of the installation of two different systems, I would embrace this opportunity to emphasise the importance that the two great electrical manufacturing industries of this country draw together rather than apart, and that they unite in a common specification for electric motive power to replace steam, through which action the final result would be tremendously improved."

Slag Encrusted Boiler Tubes.

AN elaborate report on a class of boiler trouble, which fortunately does not often worry English engineers, but is more or less prevalent in America, has been made by Mr. Harry H. Bates, one of the stoker engineers of the Westinghouse Electric and Manufacturing Company, Philadelphia. The report deals with the formation of slag on the tubes of water-tubes and the possibilities of its prevention.

At the commencement it is pointed out that "it is a daily occurrence to hear of boiler stations operating at 300 per cent. of rating or more, and it is by no means unusual that 400 per cent. of the rated capacity and more are reached." When boilers are forced to such an extent it is only natural that difficulties should be experienced which would not develop in more normal circumstances, and the choking of the passages between the tubes is among them. The extent of the trouble may be gauged from the photographs we reproduce, which show the accumulation of slag during less than a week's working, at the end of which, it is said, the boiler ceased to operate.

The author of the report gives particulars of the principal constituents of coal ash, from which it is assumed the slag must come, and shows that none of them is fusible individually at ordinary furnace temperatures. When, however, they



SLAG DEPOSITED ON BOILER TUBES

are intimately mixed with basic oxides the melting point is so much reduced that the mixture will flow in the boiler furnace. Such oxides are provided by the pyrites commonly found in coal. The fact that this impurity may be the cause of the trouble is borne out by the fact that some American coals, such as Pocahontas and Elkhorn, which contain very little pyrites, give a minimum of clinker trouble. It is the ferrous oxide produced by the pyrites which reduces the fusing temperature of the slag, while ferric oxide results in a comparatively infusible material.

Mr. Bates suggests that minute particles of slag are carried up from the fire even when the gases are rising at a comparatively low velocity. When these little particles come in contact with the free oxygen in the furnace gas for a sufficient time completely to oxidise them they become solid. If they solidify before touching the tubes or walls they are carried through the boiler as solid ash. On the other hand, in the event of no free oxygen being obtained through the fuel bed, the particles remain in a molten condition, on account of their low fusing temperature in their -ous state, and are deposited on the tubes and walls, where they may either be completely oxidised and solidified or be covered by successive coatings or layers of the same plastic material. That the latter is true to a large extent is shown by layers of a very dark vitreous material covered by a reddish brown layer or protective coating. This reddish coating is largely ferric material, and it prevents further oxidation of the dark ferrous material within by excluding the oxygen from it. A considerable portion of the material on the outer surface, especially on the tubes, is of a friable and non-fusible character, and it is of a completely oxidised nature.

Analyses of the slag taken from various parts of the boiler, where it was more or less liable to oxidation, confirmed the theory that it was necessary to oxidise the ferrous into ferric iron and several means were tried for introducing the necessary oxygen. One of the most promising experiments consisted in raising the boiler so that the height from the fire to the tubes was increased from 13ft. up to 19ft. with the idea of lengthening the time during which the globules of slag were exposed to oxidation from 0.72 second to 1.05 second. The change did not, however, prove very effective, and had the disadvantage of exposing more brickwork to high temperatures.

Mr. Bates goes on to argue that furnace construction undoubtedly has much to do with the external encrustation of the tubes with slag. The ratio of the exposed tube surface to the grate area in the case under review was 1 to 1, which, he says, is very low, and the lower the ratio, under set conditions of fuel and fuel bed, the higher will be the furnace temperature. It is apparent that the higher the furnace temperature the greater will be the tendency for the ash to fuse and stick. It has become common practice now to have the ratio of exposed tube surface to grate surface as high as 1.87 to 1, and is seldom less than 1.2 to 1. By increasing this ratio the amount of heat radiated up and absorbed is very materially increased, with a consequent reduction in furnace temperature. Unfortunately, the construction of the investigated installation did not permit changing the ratio, and, for comparative purposes, it was necessary to refer to a neighbouring station with a similar type of stoker and boiler, and using a similar coal. This second plant has had practically no trouble with slag on tubes, and uses only the soot blowers while the boilers are in operation.

An interesting difference in the two stations was that the first two rows of tubes in the former were staggered, and slag impinged on and stuck to both rows. The second row caused more trouble than the first row, as the slag took the form of icicles or stalactites, and when they became long enough and the velocity of the gas became high enough, the "icicles" bent sideways until they touched the lower tubes. This effectively sealed the gas passage of that part of the boiler. The second installation had the first two rows set one above the other. The material which struck the bottom row of tubes adhered, but the rapidity of the formation was far less. On account of this arrangement, the gases were sufficiently cooled by passing between these tubes to prevent the slag from sticking to the higher tubes, and there was no further tendency for the slag to adhere to the boiler surfaces.

When it is considered that the ash is very finely divided in the coal, and that some of it is certain to be carried up with the gas, it appears that the most fruitful field for development of means for slag prevention is in furnace and boiler design. This belief has already been justified. At the same time there is still need for further development of apparatus for mechanically removing soot and slag from boiler tubes.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCAL ELECTRICITY SUPPLY *v.* BULK SUPPLY.

SIR,—In your issue of October 27th a letter appeared under the above heading, signed "W.S." The letter purports to adduce evidence that in practically every case it is cheaper for all classes of factories to produce their own power supply. In the concluding paragraph of the letter, the writer disclaims such a contention, but as he states in the same paragraph, "In actual practice manufacturing concerns will be proportionately near one or other of the examples given," and as all these examples—for what they are worth—show an overwhelming advantage in favour of the private power plant, one must be excused for thinking that the disclaimer is merely an example of mixed thinking.

If "W. S." is correct in his estimates, then the electric supply industry of the whole world is built up on a false economic basis, and must inevitably come to an end so far as power is concerned sooner or later. Also all the manufacturing concerns taking their power from a public supply undertaking are poor business people and incapable of ascertaining their own costs. One hesitates to believe that such is the case.

There are certain special cases of industry where power can be obtained as a by-product, but only by incurring capital expenditure. These industries are the exception and not the rule. Even in these special cases a use must be found for the power, and either a special industry must be created to utilise the exact amount of power as and when it is available, or it must be disposed of to a public undertaking which can market it. If neither of these courses is adopted, some of the surplus power will of necessity be wasted. The dyeworks forming the third comparison in the letter of "W. S." is one of these special cases, where power—in this case on a very small scale—could conveniently be produced as a by-product, but it could only be produced by incurring capital expenditure and incurring extra cost for operation and maintenance. In this world it is not sufficient merely to produce a product; it has got to be marketed before it becomes of any value. A marketable product must be produced as, when, and where required. The quantity of the product in this case would be surplus power, the quantity available and the time available would be governed by the exigencies of the dyeworks, so that it is obvious that very special arrangements would be required to market the power, as it would be hedged round with conditions that no ordinary firm would accept. In making this comparison—the dyeworks—the conclusion that all heating and power could be supplied at a total running cost of £47 per annum, while with electric driving the total cost would be £1311 18s.—note the odd shillings—is about as useful as the knowledge that the energy in the sun is illimitable. We know it is, but as we cannot use it commercially, it does not help to keep power costs down.

It is the first comparison made—that of the comparative heating and power costs of a small engineering works—that will interest power supply engineers most. Capital costs have been omitted. If these had been included, the divergencies in cost arrived at would only be somewhat lessened and not removed. The misleading nature of the comparison is readily apparent by analysis of the meagre data supplied upon which the comparison is made.

It is assumed that 1 lb. of coal will produce 8 lb. of steam at 180 lb. pressure—I assume this pressure is gauge pressure. Taking average figures, assume the coal to have a calorific value of 12,000 B.Th.U. per pound. Then assume the feed water is 102 deg. Fah., and that the steam is dry and saturated; then the average boiler efficiency while on load comes out about 75 per cent.—even if the feed-water temperature is supposed to be heated up by some means, it will not greatly affect the con-

clusions to be drawn, for it has not been considered in the comparison made, and such heat as goes in feed heating is not available elsewhere. On such a small plant, such a high average boiler efficiency would not be maintained. No doubt it is possible to realise 75 per cent. on test with skilled operation and a boiler in first-class condition, but it will be freely admitted by any engineer who has any real experience of accurate test results from boilers that no factory boiler could be expected to realise much above 60 per cent. as an average. Mr. Brownlie's recent book is rather illuminating to those who have not their own data. It is further estimated that 10 cwt. of coal per week will suffice for banking, &c. Banking hours will be at least 80 per week, and the boiler will be let right down and then lighted up again at the week-end. If not, the banking hours will be 121. The amount allowed for banking appears far too low.

It is estimated that 40 horse-power could be produced at a steam cost of 20 lb. per horse-power hour with steam initially at 180 lb. gauge pressure and exhausting at 20 lb. gauge pressure. Assuming dry saturated steam and an engine mechanical efficiency of 90 per cent., this gives an efficiency ratio on the Rankine cycle of 107 per cent. approximately, which is obviously ridiculous. If the pressures are meant to be in absolute values, the result is still impossible. If initial superheat is assumed, the preceding remarks on boiler efficiency need to be considerably revised and strengthened.

It is also estimated that when bleeding off 952 lb. of steam per hour for heating at 20 lb. gauge pressure, with 600 lb. of steam per hour expanding down to the condenser pressure, that 80 horse-power hours could be produced. This is an impossible result also, assuming dry saturated steam. It is also estimated that with a compound engine with a high-pressure cylinder large enough to allow 952 lb. of steam to be bled at the high-pressure cylinder exhaust and still develop 80 horse-power, that when it is operated as a straight compound engine it will produce 80 horse-power at a total steam consumption, including driving its own circulating and air pumps, of 13 lb. per brake horse-power hour. This steam consumption is obviously far too low. If a high degree of superheat was assumed, then "W. S." had better revise his boiler performance very seriously, for it would be getting close to 100 per cent. efficiency with 200 deg. Fah. of superheat.

If "W. S." conscientiously believes that the engine results quoted by him can be obtained, he is recommended to insert in his next contract for such an engine a severe penalty clause with rejection powers, and a clause for a proper test made by an independent authority. He will then find his specified steam consumptions magically increased. It is not a bad rule to doubt everybody else's figures always, and your own occasionally.

To illustrate how utterly inadequate and misleading the first comparison is, it only needs to be stated that the comparison assumes that an 80 horse-power steam boiler and engine plant can produce the power equivalent of 170,375 electrical units at a total coal figure of 2.48 lb. per kilowatt-hour. This is for an eight-hour day and includes heating for twenty weeks and all stand-by losses. A laboratory steam plant would not do it, much less a factory plant. The comparison is at once stamped as hopelessly incorrect and misleading.

In passing, it may be pointed out that it would be a mighty poor electric 80 horse-power motor that only realised a full-load efficiency of 82.5 per cent; also that any decrease from full load would lower the efficiency of an engine far more than it would that of a motor. The full-load efficiency of the motor would be at least 90 per cent. Also the efficiency of the motor will not fall off in service. So long as it runs at all, it will run at its test bed efficiency. The same cannot be said of engines and boilers.

It cannot be too strongly emphasised that it is the average efficiency obtainable year after year that really matters so far as operating costs are concerned, and that efficiency cannot be maintained without expert supervision and ceaseless vigilance. These last two requisites are usually missing in a small power plant.

Exactly the same arguments might be used about all our domestic requirements, *e.g.*, bread, clothes and so on. We might buy flour and bake all our own bread at less cost (on paper) than if bought; purchase cloth and wear home-made garments, thus saving money (on paper). Do we do this, and if not, why not? The answer is obviously that we each have too much to do in our own special line, and that it pays the shoemaker to stick to his last, the tailor to his needle, the factory manager to his own class of manufacture, and the power manager to power production.

J. N. WAITE, M.I.E.E.

Stoke-on-Trent, October 30th.

GASEOUS FLUID EJECTOR.

SIR,—Having been engaged for several years in designing steam-operated air ejectors, it was with great interest that I read the articles by Mr. Hepburn appearing in your issues of October 20th and 27th.

Mr. Hepburn has dealt with the subject entirely from a theoretical point of view, and has evidently very little knowledge of the actual test results which can be obtained by ejectors, as some of his figures are widely different from those found in practice. All his information on the subject appears to be based on the various pamphlets and articles that have been published by the different manufacturing firms.

The "theory of depression" as described in his first article is interesting, but contains little that is new, and his reasoning is not very clear. With regard to the formula put forward connecting initial steam pressure with "depression pressure," much might be said, but it is of no practical value to the designer. To quote the example worked out on page 430, Mr. Hepburn shows that to maintain an absolute pressure of 2.5 lb. per square inch and discharge against 14.7 lb. per square inch, a single-stage ejector would require an initial steam pressure of 176 lb. per square inch. This result does not even approximate to actual figures. A few weeks ago I had the opportunity of seeing a single-stage ejector maintaining an absolute pressure of 2.5 lb. per square inch in a condenser and discharging against atmospheric pressure with an initial steam pressure of 90 lb. per square inch gauge and a steam consumption of about 10 lb. of steam per pound of vapour extracted. On test, this ejector obtained an absolute pressure of 1.5ins on an airtight system with the same initial steam pressure. I could refer Mr. Hepburn also to numerous examples of ejectors throughout the country maintaining the same vacuum on even lower steam pressures. This probably accounts for his having read that "the vacuum is unaffected by a range in initial steam pressure," but it is obvious to anyone acquainted with the various methods of air extraction by kinetic means that to lower the initial steam pressure a greater quantity of operating steam must be used to effect the same air dealing capacity.

The formula (2.2) deduced under the "theory of mass induction," which expresses the fact that the induced mass of air gets the residue of energy in the operating steam, is the only relation which interests the practical designer, as his chief consideration will always be the number of pounds of air that can be extracted per pound of operating steam under the given conditions. There is certainly a critical steam pressure below which it would be impossible to obtain, say, a 25in. vacuum, but long before this critical point was arrived at, the steam consumption per pound of air would be so great that it would not be a commercial proposition, and so in practice this critical steam pressure is never approached. A two-stage ejector would be substituted with reduced steam consumption.

This formula (2.2), however, has the disadvantage that it is not easily handled, and entails a considerable amount of work. It appears preferable to express the same idea in terms of the pressures as these are more convenient to work with. The following expression, which is easily deduced from velocity considerations on the lines of Mr. Hepburn's expression (2.2) has been used by the writer for years. It will be found to give results which closely predict actual test figures, and has been employed to estimate results of vacuum augmenters with high pressure and exhaust steam and all types of single and multi-stage ejectors.

Space does not permit a full discussion of the assumptions involved or of the effect of varying the value of the index of expansion n in the fundamental equation $p v^n = C$. In what follows n is taken for convenience at its usual value for the expansion of steam initially dry and saturated, viz., 1.135.

Let p_0 = Initial steam pressure in pounds per square inch absolute.
p_1 = Discharge pressure in pounds per square inch absolute.
p_2 = Absolute pressure on suction side of steam nozzle.
K = Nozzle coefficient, usually about .95.
a = Experimental factor depending on efficiency of compression and varying inversely with ratio of compression, usually from .65 to .8.
w = Pounds of air entrained per pound of steam.

$$\text{Then } w = K\,a \left(\frac{p_0^{\frac{n-1}{n}} - p_2^{\frac{n-1}{n}}}{p_1^{\frac{n-1}{n}} - p_2^{\frac{n-1}{n}}} \right)^{\frac{1}{n}} - 1.$$

To use this formula, a curve of experimental values must first be prepared. That is, values of a are plotted against ratio of compression. This can be done from the test figures of any one ejector, and will then hold good for any other ejector of a similar design. A small allowance has to be made in the value of a for different sizes of the same type, as the friction loss in compression tube varies inversely with the diameter. This correction can easily be embodied on the same curve. Having made this curve and for convenience tabulated values of $p^{\frac{n-1}{n}}$ likely to be met in practice, the formula is readily applied to practical cases.

To take the figues of the single-stage ejector mentioned above,
p_0 = 105 lb. per square inch absolute.
p_2 = 2.5 lb. per square inch absolute.
p_1 = 14.7 lb. per square inch absolute.
K = .95.
From curve for this design ratio of compression = $\frac{14.7}{2.5} = 5.9$ $\therefore$ $a = .75$.

Then substituting $w = .1$ lb. of air per pound steam, which agrees with test figures.

As a matter of theoretical interest, if $w = 0$ in above expression and $p_1 = 14.7$, $p_2 = 2.5$ and K and a remain as before, the result will give the minimum steam pressure to maintain this vacuum and deal with no air.

On substitution, this gives $p_0 = 60$ lb. per square inch absolute or 45 lb. gauge, and this is about what it must be, though for the reasons mentioned above, as this is not a condition of any practical value, I have never seen it tried below 60 lb. gauge and dealing with a small quantity of air.

The same method of procedure is followed for a multi-stage ejector, only it is necessary in this case to decide on the intermediate pressure or pressures, and use that as the suction or discharge pressure for each stage, as the case may be. Space, however, prevents me from going into this here, as it introduces several other points.

The five conclusions drawn by Mr. Hepburn at the end of his article are, with one exception, theoretically correct.

(*a*) is quite wrong, both in theory and in practice, as the few remarks above may show. Given an initial steam pressure p_0, an absolute pressure of p_2 to be maintained and a back pressure of p_1, then there is a definite weight of air which can be removed per pound of steam.

(*b*) I am in perfect agreement with Mr. Hepburn on this point. It is highly desirable to superheat the nozzle steam and the gain in weight of air removed per pound of operating steam will be shown if a few different values of n are substituted in above formula.

(*c*) A more efficient compressor than a reversed nozzle would undoubtedly result in a gain in efficiency. There is much that might be said on this subject, but for simplicity it will be difficult to get away from the smooth expanding compression pipe, where the kinetic energy is gradually converted into pressure energy.

(*d*) I quite agree on this heading. Multi-stage ejectors will always be more efficient than single-stage, as the compression ratio is reduced with the introduction of an extra stage. The gain in efficiency with extra stages has, of course, sometimes to be balanced against initial cost.

(*e*) There is a great deal more that might be said under this heading, as it is perfectly true that a reduction in the value of n in the index of compression will result in a greater air-dealing capacity, and Mr. Hepburn evidently knows this is actually done by one manufacturer.

The formula put forward above will not show directly the effect of varying the index of compression. It has to be slightly modified to suit the fact that the compression index is very different from the expansion index. It is, however, readily put into this form and will then show directly, by plotting, the effect of lowering the compression index.

There are many other points I should like to mention, but I hope the foregoing remarks will be sufficient to show Mr. Hepburn a few of the more practical considerations which affect ejector design.

November 1st. INTERESTED.

The Bases of Modern Blast-Furnace Practice.*

By A. K. REESE.

(*Concluded from page 464.*)

III. AUXILIARY EQUIPMENT.

Under this heading it is not intended to enter into, nor does the purpose of this paper call for, a detailed discussion of the many units comprising the auxiliary equipment of a modern blast-furnace. There are, of course, certain units which are essential to the operation of any blast-furnace. Where, for the purpose of emphasising the requirements of modern blast-furnace practice, it is necessary to discuss the modern features of these units they will be specifically referred to. There are also certain units which, while not essential to blast-furnace operation in general, are essentials, from the standpoint of economical operation, to modern practice. These will be discussed in more detail, but only so far as the principles involved in their adoption are concerned.

The auxiliary equipment, or plant required for the operation of a blast-furnace, may be divided into four sections:—

(1) The Power Plant.
(2) The Blast Heating Plant.
(3) The Raw Material Supply Plant.
(4) The Output Disposal Plant.

Equipment falling under one or other of these sections is essential to the operation of every blast-furnace—excepting, of course, a cold-blast furnace which need not be considered here. In modern practice, however, there are certain features in the details of the plant required, bearing upon the method and economy of operation, which are essential to the full adoption of that practice.

(1) The term *Power Plant*, which is used here in its most comprehensive sense, covers all apparatus for producing and utilising the power required for sustaining the blast-furnace operations. The principal among these are the boiler plant, the blowing-engine plant, the electric generating plant, the water-pumping plant, and, in some cases, the hydraulic power and compressed air plant—and it might be added the dry-blast plant. With regard to most of these items, it need only be said that they should be of the most modern, simple, and economical type, with ample reserve of power and capacity, in order to minimise those costly furnace stoppages which are otherwise likely to occur through mechanical failures, or interference with normal operation through lack of efficiency. In other respects they do not, with the exception of the blowing-engines, bear directly upon the principles of modern blast-furnace practice. In regard to blowing-engine capacity, and—in one particular feature—to turbo blowers, there is a point which it is important to emphasise. As previously stated, the volume of air required for the normal operation of a full-sized modern blast-furnace is from 40,000 to 50,000 cubic feet of air per minute. It is important that this air should be delivered in as continuous a flow—that is as free from pulsations—as possible.

With reciprocating engines, the speed and number of blowing cylinders be as great as possible consistent with engine safety and efficiency, and the range of volume delivered, with a fair degree of economy, as wide as possible. The engines should also be designed to deliver their maximum volume against pressures up to 25 lb. to 30 lb. per square inch with steam pressure or gas of quality at least 20 per cent. below the normal, in order to provide for those abnormal conditions to which every blast-furnace is liable. As regularity in air volume delivery is an essential of modern blast-furnace practice, every blowing engine should be equipped with an efficient governing device.

As above mentioned, the centrifugal or turbo blower is widely used, and is rapidly growing in favour for blast-furnace work. Well-designed blowers of this type have a number of advantages over the reciprocating type. They are simpler in design. Per unit of capacity they are lighter in weight, require less floor space, less massive foundations, and are lower in first cost. They have fewer moving parts, have no losses through reversal of motion, are lower in cost of maintenance and repairs, require less attention in operation, and are much easier and less costly to lubricate. They have the advantage of giving a continuous flow of blast delivery, being entirely free from the pulsations in delivery, within their rated capacity, characteristic of the reciprocating type. There is, however, one feature in the turbo blower, as compared with the reciprocating blower, which must be specially provided for to ensure its suitability for modern blast-furnace practice. As above stated, regularity or constancy of the volume of free air per minute, required by the furnace operator for the time being, is an essential of that practice. This volume must not materially vary or be affected by the more or less varying resistance, commonly called pressure, on the delivery side of the blower, due to the varying furnace conditions. In reciprocating blowers this requirement offers no difficulty, as regularity of the volume delivered is assured by regularity in engine revolutions, whatever the resistance, within the limits of the capacity of the blower. In the turbo blower, however, the volume delivered varies both with the engine revolutions and the resistance on the delivery side. The turbo blower, therefore, requires for its satisfactory application to modern blast-furnace practice a special type of governing or controlling device in order to assure the delivery of a constant volume of blast per minute against the varying resistance offered by the varying furnace conditions, that is, a volume controller. For many years this feature in the turbo blower was a serious drawback, notwithstanding its many other advantages, to its adoption for blast-furnaces. Its general adoption and growing use in recent years is directly due to this difficulty having been successfully solved through the design and application of an efficient volume regulator.

(2) *The Blast Heating Plant* consists essentially of the hot-blast stoves and their connections, for receiving cold-blast from the blowers and waste gases from the furnace, and for delivering hot-blast to the furnace and

* Iron and Steel Institute. York Meeting, 1922.

consumed gases to the atmosphere. Under this heading should be included another installation which, while not essential to blast-furnace operation in general, is from the standpoint of economy an essential part of modern blast-furnace equipment. This is the gas-cleaning plant, or rather, a rough gas-cleaning plant as distinct from the plant required for the high degree of gas-cleaning necessary for use in gas engines.

The advantages and economies obtainable by the use of clean gas as compared with uncleaned gas are many and of very considerable importance, and far outweigh the cost of installation, operation, and upkeep, &c.

Though this question has already been fully discussed by various writers, a number of these advantages, some of which also apply to the boiler plant, are enumerated as follows :—

(1) A much higher thermal efficiency of the gas is obtained through more perfect combustion, by better control of air and gas mixture, and the elimination of fume and other heat absorbing solid matter, with the consequent increase in the heat units available for absorption by the stove checker bricks and boiler flues.

(2) The saving of the labour constantly required for cleaning stoves and boiler flues.

(3) The saving of labour and materials required for repairs to stoves necessitated by the fluxing effect of the solid matter in uncleaned gas on the brickwork.

(4) The much longer life of stove linings through the absence of these destructive effects of uncleaned gas.

(5) The much greater time service per stove—and per boiler—through the elimination of lost time for cleaning and repairs.

(6) The much greater possible heating surface per unit of stove volume through the use of smaller checker openings, and the higher efficiency thus obtainable.

(7) The greater regularity in blast temperatures obtainable through the maintenance of a higher average stove efficiency.

(8) The hot-blast being practically free from abrasive dust there is an absence of its cutting—sand-blast—action upon the linings of the hot-blast connections and of the iron and steel fittings where blast leaks are liable to occur.

The very large volumes of blast used in modern blast-furnace practice naturally necessitate stoves of much greater heating surface than is required in the older practice. The modern hot-blast stove is, therefore, constructed with a heating surface of 70,000 to 85,000 square feet ; checker openings are from 3in. to 4in. in diameter or square, enclosed in a shell 20ft. to 22ft. in diameter and from 95ft. to 110ft. in height. There are usually four stoves per furnace, though in some cases seven stoves are provided for two furnaces, one being arranged so that it may be used on either furnace. This is open to the objection that the two furnaces may at times both need the extra stove to the probable disadvantage of one. Each furnace should have its own complete equipment when both are in operation. The stove shells and their fittings and connections must be of considerably greater strength than in the older constructions to withstand the higher pressures they are subject to, and the latter of ample area to accommodate freely the large volume of air and gas passing through them.

A small but important feature in modern blast-furnace equipment is the blast temperature regulating pipe, which consists of a connection between the cold and hot-blast mains. The purpose of this connection is for admitting cold-blast direct into the hot-blast main to enable the regulation of the blast temperature, usually downward, when required. The cold-blast connection may be made at any convenient point in the cold-blast main, but the connection into the hot-blast main should be at the furthest possible point from the furnace to intercept the blast from the nearest stove, in order that the cold and hot-blast may have as great as possible time to thoroughly mix, as otherwise there is danger of the cold and hot-blast entering the bustle pipe, or circular main, from which the tuyere connections are fed, not thoroughly mixed, when some of the tuyeres will receive blast of higher temperature than others with consequent uneven working of the furnace.

(3) *The Raw Material Supply Plant.*—While unquestionably economy in the cost of handling the raw materials for supplying the furnace has grown to be a first consideration in the design of the plant under this heading, particularly in recent years of high labour costs, the original incentive to the adoption of mechanical handling was rather one of necessity. The rapid increase in blast-furnace outputs necessitated such large quantities of materials that they could not be efficiently handled, if at all, by the older methods of manual labour. It was therefore necessary to install mechanical charging devices. Labour displacement rather than necessary labour saving was the primary incentive, though the latter was undoubtedly recognised as an important consideration.

A very important labour-saving feature is that the raw materials shall be delivered to the works, when by rail, in self-discharging hopper wagons of as large capacity as possible, with "one man" opening and shutting doors; when by sea direct from the ship, by means of large capacity grabs to a transfer travelling bridge, which delivers the material so received direct to the furnace bins, to the stockyard situated adjacent to the bins, and directly under the transfer bridge, or into railway wagons. The bins usually consist of a double row of slanting bottomed enclosures, constructed of steel or concrete, varying in number according to varieties of ores used, and running usually in a direction perpendicular to the length of the transfer bridge, the inclination of the bottom being towards the centre line between the two rows of bins and at an angle somewhat greater than the angle of repose of the materials. The bins are each of moderate capacity, but in total capacity usually sufficient to supply the furnace for from forty-eight to seventy-two hours only, as by means of the transfer bridge ample facilities are at hand to keep them filled from the stock piles if necessary. Each row of bins forms the support for a standard gauge railway track for conveying to and discharging into the various bins such materials as are received in railway wagons. A transfer car also runs on this track, or on a separate track supported by the bins, for distributing the materials delivered by the transfer bridge from the stock piles or direct from the ships. The railway wagons are elevated to the roads over the bins, either by an electric lift, or over an incline where there is sufficient room, the wagons descending to the ground level either over the same incline or a similar one at the other end or by means of a wagon drop.

Below and on the centre line between the double row of bins there runs an electric transfer car for conveying the materials from the bins to the hoist skip or bucket. The materials are discharged from the bins by gravity into a receptacle on the transfer car, through suitably controlled openings situated at the lower limit of the inclined bottoms of the bins. The transfer car also carries as an integral part of it a weighing machine, upon the beams of which rests the receptacle for receiving the materials from the bins, so that any predetermined weight of material may be discharged into the transfer car receptacle from any particular bin. The whole of the operations in connection with the transfer car are carried out by the driver of the car, whose position is such that he has under his control and observation the discharge of the materials from the bins, the weighing of the materials, and the driving of the car. The capacity of the transfer car is such that it can deliver in each trip a quantity equal to the maximum load of the hoisting skip or bucket.

Various means are in use for assuring that the materials are well distributed as they discharge into the transfer car receptacle. From this receptacle the materials are discharged through a suitably controlled door in the bottom into the hoist receptacle, or, as in some arrangements, the transfer car receptacle is hoisted direct from its seat on the car to the top of the furnace.

Several methods of hoisting the materials to the top of the furnaces are in use in modern blast-furnace equipment, which may be divided into two classes—the skip inclined hoist and the tub or bucket hoist, the latter consisting of either an inclined bucket hoist, or a vertical bucket hoist with a horizontal transfer bridge at the top. As usual where several methods are in use for doing the same thing, engineers and operators differ as to which provides the greatest number of desirable features for its purpose. As far as this paper is concerned, however, the purpose is the same in each method, and the author does not, therefore, propose to enter into a discussion of their relative merits.

That purpose is obviously to deliver the solid raw materials required in the production of pig iron to the top of the furnace, and to distribute them as uniformly as possible on and around the furnace charging bell. This is a feature of the greatest importance, as has been shown in the discussion of the question of distribution under the section on Preparation of Materials.

(4) *The Output Disposal Plant.*—The principal output from a blast-furnace is, of course, pig or molten iron, the others being slag and gas.

With modern blast-furnace equipment the pig, or casting, bed has ceased to exist as an essential part of the furnace equipment, the whole of the output being run into ladle cars of varying capacity, from the simple open top type of 30 or more tons to the large enclosed type of 100 or more tons capacity, though in some cases even the use of hot metal ladle cars is eliminated, as will be described later in connection with the casting machine. When the molten metal is taken to the steel works receiver or mixer there is an end of it as far as the blast-furnace is concerned, excepting when the quality is not satisfactory to the steel works manager. When all or any portion of the output is required in the form of pigs, the molten metal is run into ladle cars for conveyance to a casting machine, which is usually located at some point away from the furnace, convenient to railway connections, or, as in some more recent arrangements, the casting machine is located adjacent to the furnace, the molten metal being run direct into a receiver from which it is teemed into the casting machine feeding troughs, thus eliminating the necessity for hot metal ladle cars, except for such molten metal as is required for steel-making.

Though several types of pig-casting machines have been designed, the original or Uhling design, with various modifications and improvements for handling the molten and cold metal, is the type most usually installed at present. This machine consists of an endless chain of cast-iron moulds of about 100 lb. capacity each, and of a shape to allow a free discharge of the cold metal. The moulds are key bolted to a flexible frame carried on small flanged wheels which run on an inclined way rising from the pouring end. The molten metal is poured from the ladles, which are tilted by a power device, into a shallow basin from which it runs through feeding troughs into the moulds as they rise slowly from their return journey and pass under the discharge end of the troughs. To prevent the molten metal burning or sticking to the moulds, they are coated with a solution of limewater, which is sprayed upon them as they return to the pouring end upside down, under the machine, the limewater being blown upward by air jets in the lime tank. Owing to the heat of the moulds they quickly dry in readiness for the molten metal before they reach the feeding troughs. At the upper end of the train of moulds as they turn over to begin their return journey, the metal, which by this time has solidified—the incline is designed of sufficient length for this purpose—freely falls from the moulds on to a chute from which it discharges either direct into steel-bodied wagons where it is water-sprayed for cooling, or on to an inclined travelling endless plate conveyor which passes with its burden of hot pigs through a water-filled tank of a length sufficient to cool the pigs below the ignition point of wood. At the upper end of the conveyor as it turns for the return journey the cold pigs slide off into a chute and are discharged into railway wagons.

Machines are built single strand or multiple strand according to the capacity required, each strand consisting of a single chain of moulds having a capacity of roughly 500 tons per twenty-four hours.

While the structural parts of these machines were formerly built entirely of steel they are now constructed of ferro-concrete, owing to its more lasting qualities and lower cost. In addition to the necessary facilities which it provides for casting the large outputs of the modern blast-furnace, the pig-casting machine, the successful and satisfactory operation of which has been thoroughly demonstrated through many years of use, has very much simplified the handling of molten pig iron by eliminating the many objectionable features of the older method of casting in sand beds, and breaking by hand or by hydraulic or electrical pig-breaking machines, besides effecting considerable economy of labour and saving in waste.

The disadvantages of sand-bed casting and the advantages of the machine method of handling molten pig iron may be enumerated as follows :

Disadvantages of the sand-casting method :

(1) Difficult and high-priced labour required.

(2) Large quantities of clean sand required.

(3) Imperfect results, core jumps, plated beds, irregular breaking, and irregularity in sizes of pigs and sows.

(4) Heavy waste in runner scrap.

(5) Slower melting of sand-covered pigs, and cost of melting the sand on the pigs, in the steel furnace.

(6) Deleterious effects of sand-covered iron in basic steel furnaces.

Advantages of the pig-casting machine method :

(1) Immediate removal of molten metal from the immediate vicinity of the blast-furnace. (This, of course, does not apply where the metal is run direct into a receiver adjacent to the furnace, as above described ; but the author believes this arrangement has not yet been widely adopted, and is of opinion that, notwithstanding the slightly extra cost of ladle cars, it is better to remove the molten metal to a safer distance in view of the disturbances which sometimes occur in the immediate vicinity of blast-furnaces through break-outs, explosions, &c.)

(2) Practically no manual labour required.

(3) Sand-free iron.

(4) Uniform size of pigs of iron, and no heavy sow pieces.

(5) Facilities for disposal of the output always in readiness.

(6) Great reduction in runner scrap produced when casting.

(7) Saving in labour charges.

(8) No core-jumps or plated beds—unsaleable iron requiring extra labour for breaking and handling.

(9) A difficult and very trying class of labour is dispensed with.

(10) Where week-end iron only is cast, the difficulty of finding special labour for these days only is eliminated.

A discussion of this heading would not be complete without reference to the slag and gas, both of which form part of the furnace output.

While there are no special methods of slag disposal which may properly be said to apply particularly to modern blast-furnace practice, it may not be amiss to refer to some of the methods in use at modern plants.

The most usual method is, of course, that which is now generally used at all, except the oldest, layouts—where the slag is still run into beds, allowed to cool, then broken by hand or drop ball, and shovelled into wagons—that is, by means of large capacity, self-discharging, mechanically operated slag ladle cars, in which the slag is conveyed to some point more or less distant to get it out of the way.

Where, however, recovery of the slag is desired for special commercial purposes, special methods are used, such as blowing steam through the molten slag for the production of slag wool ; running the molten slag into tanks of water for granulating for cement making or other uses ; running into special receptacles and cooled in layers for producing a solid product for concrete making, &c. As stated, these processes are for special purposes, and do not apply generally.

With regard to the gas there are a few points also which may be mentioned.

In view of the large volumes of gas produced in modern furnaces with large outputs, it is of great importance that ample areas shall be provided in the gas out-takes at the furnace top, not only to provide for the large volume of gas to be discharged through them, but also to reduce its velocity to a minimum, in order to lessen as much as possible the tendency for the smaller particles of solid materials to be mechanically carried out with the gas. For this purpose it is usual to provide four equally distant outlets of the largest size consistent with structural safety. These outlet connections are inclined as steeply as possible upward, and are carried well above the furnace top before the gas is admitted to the downward connections, in order that any larger materials, which may at times be projected from the furnace, may fall back into it and not enter the downtakes.

In some designs baffles are placed in the elbow of the uptakes in such a position that they will intercept these heavier pieces, thus avoiding the necessity for carrying the uptakes so high. A further reason for the multiple equidistant outlets is to prevent any tendency of the gases in the upper portion of the furnace to channel towards one side, as they tend to do in older furnaces with one outlet, thus reducing the active area in the upper reducing zone of the furnace.

IV. Method of Operation.

In the foregoing pages the author has endeavoured to define in some detail those factors which enter into, and make possible, modern blast-furnace practice. They are the elements out of the adoption of which that practice has developed. He has therefore designated them "The Bases of Modern Blast-Furnace Practice."

Certain operative features have necessarily been referred to in connection with the discussion of these factors ; but so many of the details of operation, or management of a blast-furnace, are based on practical knowledge, acquired only by years of experience and common sense, that any detailed discussion of them is not possible in a paper of this nature.

It would not, however, be complete without some reference to an essential difference in the method of operation by which the improvements in results, made possible by the adoption of these factors, are obtained, and the method of operation still prevalent in many localities where modern practice has not been adopted. In modern practice the nearest possible approach to uniformity in all controllable factors is a first principle in order to obtain the nearest possible approach to uniformity of action within the furnace. Reference has already been made to the importance of this question of uniformity in various connections, *including uniformity or regularity of blast volume, irrespective of furnace pressure*

or resistance. In the older practice just referred to as still prevalent in many localities, the volume of blast is varied with the furnace resistance, that is, the varying conditions within the furnace are permitted to cause lack of uniformity or irregularity in the volume of blast delivered to the furnace. This method being contrary to the principle of uniformity of all controllable factors is totally inapplicable to modern practice.

As the principles involved in the comparison of these two methods of operation were outlined in some detail in the author's evidence before the Iron and Steel Industries Committee, he will not state them here. Suffice it to say that blowing by constant volume irrespective of furnace resistance is the method of operation essentially employed in modern blast-furnace practice.

The actual volume of blast per minute, the number, size, and length of projection of the tuyeres inside the crucible walls, the weight of coke per round of charge, the rotation of coke, ore, and flux in the charge, the degree of bosh wall cooling, &c., are all operating conditions determinable, for any particular furnace and set of materials, within certain limits by experience only.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Trade and the General Election.

It is quite usual for political crises to check business on the iron and steel markets. The trade depression has been so deep-rooted in the Midland iron and steel producing districts, however, that the present political situation has had little if any effect in this direction beyond the natural unsettlement which must accompany such an upheaval. Indeed on this occasion an opposite result appears to be general. For some time the Birmingham manufacturers have advocated a policy of non-interference on the part of the Government, not only as regards wage disputes but in matters affecting industry generally. Apart from partisanship, it is felt, in iron and steel circles here, that a new Parliament may have some effect in dispelling the enervation which has so long possessed the commercial world. Mr. Bonar Law is well known on the Birmingham Exchange as a successful merchant, whose business career was spent in connection with this industry, and his name gives confidence. Next week's polling is, of course, affecting business in so far as the diversion of the energies of buyers and sellers into electioneering is concerned. There was probably more talk about General Election prospects on the market to-day—Thursday—than about business. Should the result be such as to restore confidence in the business world, then the trade omens in other respects for 1923 are happily not considered unfavourable.

Falling Bar Iron Values.

Business at the local finished iron mills continues to show slight improvement, makers of best grade bars finding an improved demand from the engineering branches and producers of inferior grade bars securing additional business by giving way in the matter of price. Though makers of nut and bolt bars continue to complain of the unremunerative character of prices, competition from Belgium has become so severe and orders have been going abroad to such an extent that many of the mills in Staffordshire, realising that if they are to keep the mills going they must get orders, have perforce had to reduce their quotations. Some ironmasters are reported to be accepting quotations which can only result in a loss in an endeavour to stimulate business. Other makers, however, are equally steadfast in refusing to entertain any such position, and deal only with orders which produce an economic result, even if a poor one. Those firms which are willing to accept lower prices are again taking a few orders from the nut and bolt manufacturers of the Darlaston area. Their prices are round about £9 10s. to £9 12s. 6d., in contrast with £8 for foreign bars; but uniform quality, convenient selection of sizes, and delivery at short notice, go far to neutralise the difference. Belgium prices, moreover, are based on a minimum of five-eighths size, extras applying to smaller sizes, whereas the home basis covers half-inch bars. Demand for fencing bars at £9 17s. 6d. is, in the circumstances, fairly good. Marked bars at £13 10s. continue to be called for by the engineering trade in small lots. Good second-class bars, used for general utility work, are in not more than moderate request at £10 10s. to £10 15s. A little revival in the tube trade is timely, and will be welcomed by makers of strip, who have been experiencing a lean time. Iron tube strip is quoted £10 10s. to £10 15s., and steel strip can be bought at £10 or thereabouts. It is stated that some gas undertakings lately have made their tube orders conditional on the employment of iron, in view of the alleged longer life resulting from the use of this material.

Galvanised Sheets.

Galvanised sheets maintain their advance at £17 per ton f.o.b. Liverpool for 24 gauge corrugateds, though lower prices are understood to have been accepted in some cases. Orders continue to come in steadily from various foreign buyers. Demand, while it is improving, is still unequal to the capacity of the plant. The price maintenance is mainly due to the continued high cost of spelter. Makers can now buy their sheet bars down to £6 17s. 6d.

Irregular Steel Values.

Steel values continue irregular. The normal price of angles in this district is now £8 15s., and one or two North-East Coast firms who quote more have no chance of doing business. Small bars are also obtainable at £8 15s. Consumers of steel billets bought somewhat heavily within the past fortnight, taking advantage of the comparatively low price of £6 17s. 6d. This week prices have improved a little, the current quotation ranging from £7 to £7 5s. This rise in value coupled with the fall in the Belgian and French franc, has given a renewed opening for foreign competition, which has recommenced in earnest. Continental material is being pushed with an assiduity which is causing the home producer increased anxiety. Finished steel, as well as half products, are being put on the market at prices to which there can be no effective response unless the cost of production at home can be reduced. The Belgians have reduced their quotation for small bars from £8 5s. to £8 2s. 6d. Staffordshire mills require £8 15s., and more if they are to make a profit out of the transaction. Lancashire houses that were asking £10 for their small steel bars now name £9 15s. They have lost their hold on business in this district for some time past. Belgian joists are also being offered at lower prices, £6 5s. f.o.b. Antwerp being quoted, that representing a fall of 7s. 6d. per ton from the quotation of a fortnight ago. Belgian makers now comply with British specifications regarding steel for ordinary building, and this will widen the market for such foreign material. Belgian and Lorraine billets can be bought at £6 10s. delivered, and a lot of business is said to gave been done with buyers, who consider the inevitable delay in delivery compensated by the much lower price. It is believed that home prices will have to fall proportionately to the continental competition. The prospects appear to be brighter for the steel trade generally, an improvement indicated by the increased production in Scotland, and the restarting of some steel works in Middlesbrough after long periods of idleness. The disadvantage of high railway rates continues to press severely upon this district, construction engineers, in particular, complaining of the commanding position held by competitors on the coast because of their avoidance of these charges.

Pig Iron.

The district demand for both foundry and forge pig iron has expanded slightly, though the local ironworks are consuming so little of the latter material that stocks are accumulating. Smelters generally are selling their output, though it has to be remembered that two furnaces have had to be extinguished in this district, and there is consequently a lighter tonnage to be disposed of. Derbyshire No. 3 foundry iron is still sold at 82s. 6d. at furnaces, and Northamptonshire at 80s., though these prices are very firm. Indeed, a few sellers of Northamptonshire pig claim to have this week obtained advances ranging from 2s. to 2s. 6d. per ton, although this does not by any means cover the extra cost of production resulting from dearer coke. Furnace owners are generally agreed that their most formidable difficulty is the price of coke, which remains strong under the influence of an active demand for export. Smelters are asking themselves how long this position is likely to continue. Many of them are unable to make a profit under existing conditions, and there is a threat of further furnaces stopping in the new year unless relief is forthcoming in production costs.

The Birmingham Brass Trade.

The brass foundries in the Birmingham and Black Country area are feeling the impetus of improving trade. Better orders are being received from customers at home, while there are indications of a renewal of vitality in those colonial markets which usually make large purchases of brass products from this district. The improvement is enough to be clearly perceptible in the absorption of additional labour and the lengthening of the hours worked at factories which have been on short time. There is more being done at the rolling mills, though, with the greatly increased productive capacity, it will probably be a long time before full employment rules.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

The markets here are now rather more disturbed by the political unrest which must exist in circumstances like the present, but as a rule Manchester men do not seem to be so much affected as the business men in other districts. It is, however, highly improbable that any serious change can come over our markets until the election is over, and we know to some extent what sort of industrial policy is to prevail. Demand all round is bound to be restricted for a time, and yet there are some signs that industry is beginning to recover, if only to a small extent. At any rate, the problem of the burden of taxation, which is really at the root of unemployment and restricted trade, is receiving more attention now than for a long time past.

Metals.

The market for copper has again become quieter, but there has been very little change in prices, and practically none in consumers' copper. The upward movement in standard copper was purely speculative, as is shown by the fact that while it was in progress the price of best selected ingots was reduced by £1 per ton. In the United States there has been some falling off in the demand for copper, manufacturers finding that their orders for finished material are not increasing as they should. Possibly the American manufacturer will be quicker than his British compeer to find out that unnecessarily high prices, considered in relation to raw metal values, are standing in the way of a revival of consumption; and when he does accept this truth it will not be long before the British prices are also affected. With regard to the export of manufactured copper metal, it is noticeable that India declines to buy at all freely, and no doubt the reason is that the large number of Indian merchants who usually carry country stocks of copper and yellow metal sheets, are simply waiting for the prices quoted to correspond with the raw metals. The demand here from engineers is still very poor, but some people say that it is a little better than it was, so far as ingot metal is concerned. This may well be, because there is no probability that English ingot copper will be any cheaper, whatever may happen to the prices for manufactured metal. There is, however, a very large amount of cheap gun-metal and brass scrap on this market which can still be bought at very much below its intrinsic value. This is shown by the prices which the scrap merchants offer when collecting these alloys. For gun-metal which would cost over £60 per ton to make, they offer only £42, and for brass which would cost £50 to make, they offer about £30, or perhaps in some cases £32. This is not the case with scrap lead, which fetches within £3 per ton of new pig lead. The market for tin had a sharp set-back, but it is clear that the group having control of the market does not yet intend to allow prices to fall. The drop of £5 per ton was quickly recovered at the end of last week, and it looked very like a manœuvre to shake out some of the weaker holders of metal. It seems quite possible that the price of tin may yet be forced up higher, but at the same time it is well for the consumer to be upon his guard. The state of trade and of demand for metals is not such as will justify high prices for tin. The market for lead keeps very firm, and any little set-back is soon recovered. The "backwardation" stood, at one time, at 30s. per ton, but it has since been reduced to about 25s. Apparently, the supplies from Spain and Australia will still be only small, and it is not clear that Mexican lead will arrive in quantities sufficient to fill the gap. The trade demand in this country shows signs of lessening for a time. Spelter remains quite a firm market, and there seems to be a better demand for galvanised sheets, which will mean a larger consumption of metal in that section of the trade. The advance in the price of these sheets, amounting to £2 per ton, did not seem to have any effect in checking sales. As for supplies of spelter, some has been coming from America, and this caused a temporary set-back in the price; but there is very little being offered from the Continent, and one does not see yet much chance of the supply becoming too large for the needs of the market.

Pig Iron.

The market here for pig iron is better, in spite of the diversion of attention from trade to political affairs. There is a distinct feeling that the Midland prices for foundry iron are lower than they need be, and as they do not afford much margin for the makers the conditions appear to be ripe for an advance. This will probably be small, for the state of the foundry trade is not good enough to bear dear pig iron; but it is argued that if in Cleveland the ironfounder can pay 92s. 6d. at the furnace for common No. 3 foundry iron, there is no good reason why the Midland maker should have to sell at 82s. 6d. A good deal of Derbyshire No. 3 has been sold at this price for delivery up to the end of the year, and some into January and February, so that the inquiry for small lots is not now so large as it was; but the selling agents of the Derbyshire furnaces are now trying to obtain 2s. 6d. per ton more, and one cannot help thinking that they may succeed. Even then Derbyshire iron will still remain one of the cheapest reliable foundry irons in the country. The report that the home demand for Cleveland at 92s. 6d. is increasing is taken as a favourable sign. More furnaces are being put in, and it is possible that the time is nearer than was expected when the output of British pig iron will be approaching normal figures again.

Steel.

There is no movement here in manufactured steel, and the demand seems to be confined to small parcels at the old prices. The market, however, is no worse than it was, and may perhaps be a trifle better in feeling. Continental steel prices (in sterling) are reported a little better than they were.

Scrap.

The inquiry for melting steel scrap is rather better, and the feeling in the market is less depressed. Wrought scrap is not altered, but if it be true that the ironfounders are doing better—as one may perhaps assume from their buying of pig iron—then it cannot be long before a better demand springs up for cast scrap.

BARROW-IN-FURNESS, Thursday.

Hematite.

The demand for hematite pig iron is increasing gradually, and there is every indication of trade becoming so active as to require more furnaces being put in. Smelters are cautious, having to be assured of orders before deciding on a greater output. There is a greater tendency on the part of customers to book forward deliveries, and this action on their part will be the determining factor as regards additional furnaces. There is talk of two more going in in Cumberland. Scotland is providing more orders, and the improvement in the shipbuilding and engineering trades on and about the Clyde is expected to increase business in the early future. Cargoes are being shipped to Glasgow and also to South Wales, which is also taking deliveries from Ulverston of ingot moulds. The quantity of special iron smelted is increasing, and the Midlands is providing many customers. Both in special and ordinary mixed numbers Sheffield is becoming a bigger customer.

Iron Ore.

The iron ore trade is improving gradually as the local demand increases, and there is also an improvement in the development of trade outside the district. There is every reason to hope for a much better trade than to-day in a few months' time. The tendencies are all in that direction. Spanish ore is not coming in yet, for stocks held at docks have to be used up.

Steel.

The steel trade at the moment is dull. In Cumberland the tire department is engaged, and in Barrow the Siemens, foundry and hoop mills are employed. There is not much being offered in the steel markets at the present time, but there are hopes of better things in the early future.

Shipbuilding and Engineering.

As was hinted in these notes a few weeks ago,

the possibility of shipbuilding and engineering orders has now become an actuality, Vickers Limited having secured the contract for the building of a large liner for the Orient company. The vessel will be of over 20,000 tons, but at present the full particulars have not been made public. This will provide work for many hands which have been idle, and will no doubt lead to further contracts being entered into. Further developments may be expected shortly.

SHEFFIELD.

(From our own Correspondent.)

Steel Trade's Slow Recovery.

WRITING about the steel trade of Sheffield is not a much more cheerful task than it has been for a long time past. While it is generally agreed that some improvement is taking place, the movement is painfully slow, and is still having very little effect on some of the most important departments. Some real signs of activity are shown in the basic branch, but this is more or less centred at Rotherham, and Sheffield derives small benefit from the movement. As to acid steel, I can only repeat what I have said in recent weeks, namely, that, although there is some upward trend, a great measure of depression continues. The engineering works are only very partially employed. As for crucible steel, it remains in a very unsatisfactory condition, for, while a few small orders are booked occasionally, they amount to very little in comparison with what the trade requires. For steel on which a greater or less amount of work has been done, and for tools, an increasing number of orders is being received, but here again the total bulk is not great, as the quantities specified are generally merely such as will satisfy immediate requirements.

"A Ray of Sunshine."

How bad the position in Sheffield has been for a long time may be gauged from the fact that the chairman of an important steel company has welcomed, as "a little sunshine," the circumstance that the firm's forges and rolling mills have worked two weeks consecutively. This was the first time for eighteen months that such activity had been enjoyed. The firm in question is Kayser, Ellison and Co., Limited, which lost £39,640 last year, and which is consequently unable, for the first time in its history, to pay any dividend on either ordinary or preference shares. A second very disappointing result announced during the past week is that of the Sheffield Forge and Rolling Mills Company, Limited, another concern which has for many years enjoyed great prosperity and has been high in the favour of investors, but which during the year ended June last, lost £53,321. Against this there was a balance of £5063 brought forward from the previous year, and the directors have decided to meet the deficiency by transferring the reserve fund of £30,000, the reserve for special renewals and extensions of £18,223, and a small sum from the insurance fund.

Railways, Shipping, and Motors.

One hears of rather better employment in the railway steel department, although the improvement is not equally divided. There is some activity among the collieries, in renewing rolling stock, and this is helping to alleviate the situation. This branch of the industry is looking to the Metropolitan underground railway schemes, and other developments by home companies, to provide it with much work in the future. The demand for shipbuilding steel continues very meagre, but the reports of the booking of new tonnage on the Clyde give ground for hope of improvement. The fact that Vickers Limited have booked an order for a 20,000 ton twin-screw turbine steamer, fitted for oil-burning, for the Australian mail service of the Orient Line, is also cheerful news, as it will no doubt bring work to the firm's Sheffield departments. The motor industry is making increased calls upon Sheffield, and appears to be progressing. It is sending in a fair number of orders for alloy steels, magnet steel, magnets, and small steel castings and forgings. There is a good demand for steel strip, and the trade in wire rods has lately been on a considerable scale.

Table Cutlery Busy.

The table knife department, which has been the most active side of the cutlery trade for a considerable time, maintains its lead and even increases it. During the past week it has received a number of large orders, chiefly for cutlery of the stainless variety. Some of the best of these have been from Canada and Australia. Many of the factories are now very busy, but this state of things is not found all round, as severe price competition is driving much of the business away from the ordinary channels. The sales of celluloid for handles are above the pre-war quantities, and prices of the material are from 10 to 15 per cent. lower than they were a twelvemonth ago. Apart from the table knife branch, cutlery is very quiet. In the pen and pocket-knife department there has been comparatively little manufacture for months, owing to a wages dispute which has had an almost all-round effect. A few firms which had not been affected have managed to keep their men fairly well employed. The dispute referred to has now been settled. It was a lock-out of spring-knife cutlers, grinders, and finishers, to enforce a new price list, and has lasted sixteen weeks. Work was resumed on Monday this week. A percentage reduction takes effect at once, and the two sides will continue negotiations with the object of arriving at an agreed list for each section of the trade.

The Boom in Electro-plate.

The other side of the old light trades of the city—silver and electro-plate—continues to display the same activity which I have several times recorded. The Christmas demand is proving a great deal better than was expected, and orders continue to roll in. All the firms are not participating in the fulness of the activity, but most of them are reaping much employment from the demand and instances of double-shift working are not difficult to find. The pressure is expected to continue until Christmas, and in some lines it may be maintained a little longer.

New System of Sewage Disposal.

The list of municipal engineering schemes in hand or in contemplation in the district—many of them started with the object of providing work for the unemployed—continues to grow. Some important additions have just been announced by the Sheffield Corporation. Principal interest, perhaps, attaches to the decision to proceed with a further section of the conversion of the sewage system from contact-bed to bio-aeration, or activated sludge, as devised by Mr. J. Haworth, the manager of the sewage disposal works. Mr. Haworth's method, which has been fully described on more than one occasion, holds out promise of revolutionising present ideas as to sewage treatment, and it has attracted wide-spread attention among engineers. The first section of the conversion, covering one-sixth of the whole scheme, will be completed by about March next, at a cost of £52,000. The Corporation is now proposing to proceed with a further portion, to complete four units of the plant, at a cost of £64,262, if the Unemployment Grants Committee's contribution can be obtained.

Other Municipal Schemes.

Sheffield Corporation is also proposing to erect two new schools, one at Phillimore-road, to cost £26,250, and one at Bolsover-hill, to cost £29,480. It is putting in hand an extension of the Fulwood tramway route, which will involve an expenditure of £14,450 on permanent way and £1538 on overhead equipment, and the Tramways Committee is strongly of opinion that the extension will prove a paying one in a short time. Road improvements are to be carried out, in connection with this extension, and also at the Woodseats end of the city. The Corporation has now completed 2025 houses out of a total of 2268 in its approved schemes, and 78 are in hand. The Ministry of Health has sanctioned the borrowing of £20,200 in connection with the erection of the sixth instalment of houses on the Stubbin estate, and the Estates Committee has authorised the City Architect to advertise for tenders for the erection of 107 houses on the Manor estate. Doncaster Town Council has just brought into commission large power-house extensions at the electricity works. The new plant, which includes two 3000-kilowatt turbo-generator sets, has cost about £86,000, but the total outlay on the extensions will be about £100,000. Doncaster is now thoroughly up to date in regard to efficiency of electrical installation, and the development of the town and district has been borne in mind in planning the scheme, which has been carried out under the direction of Mr. Windle, the electricity engineer. The Doncaster Council is also pushing forward its housing schemes, and has just let, to a Sheffield firm, tenders for the erection of a further batch of sixty dwellings on the Carr House estate. The houses are to be of the non-parlour type, and to cost £345 each. The Skegness Council is proposing to spend £16,500 on the improvement and extension of the town's sewage works, and a Ministry of Health inquiry into the scheme was held last week.

Personalia.

In the municipal elections on November 1st, three men well known in the steel trade were returned to the Sheffield City Council. They were Messrs. A. M. Jack, formerly managing director of Hadfields Limited; S. Warren, steel manufacturer; and G. Addy, consulting engineer. The last-named is an old member of the Council; the others are newcomers. Lieut.-Colonel J. H. Leslie, a local director of Vickers Limited, was also a candidate, but was unsuccessful. The new Mayor of Rotherham, Councillor A. R. Habershon, is a member of the firm of J. J. Habershon and Sons, steel rollers and manufacturers, Holmes Mills, Rotherham. Sir Robert Hadfield, head of the firm of Hadfields Limited, has been elected president of the Engineers' Club, London. The late Mr. John Benjamin Tompkin, governing director of Flockton, Tompkin and Co., Limited, Newhall Steel Works, Sheffield, who died on August 5th, left estate valued at £112,489.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Revival.

DESPITE the disturbing influences created by the political situation, the general trade position in the North of England continues to improve, and there is a confident feeling that when the General Election is over business will show an appreciable expansion all round. The re-starting of the Cleveland steel works, the success of Messrs. Dorman, Long and Co. in securing the contract for the thousands of tons of steel required for the new floating dock being built on the Tyne, the starting of two more blast-furnaces on Tees-side, and the placing of an order for two large steamers with the Furness Shipbuilding Company by London owners, are all indications that trade is on the up grade, and work more plentiful.

Cleveland Iron Trade.

There has been a renewal of interest in the Cleveland pig iron trade, and better business both on home and foreign account is reported. The ironmasters are now in a fairly good position. With the orders now on their books they have disposed of a substantial proportion of their make to the end of the year, and some orders have been booked for shipment to America as far ahead as March next. There has, in fact, been a revival in the American demand. Cleveland prices, on a c.i.f. basis, are still below the American quotations, and in addition to the steady buying of special foundry iron qualities there have been urgent inquiries for ordinary foundry grades for prompt shipment to United States ports. For Scotland, too, there is a fairly active demand, but continental inquiries are few and far between, the fall in the exchanges having checked business in that direction. An easier tendency in the fuel market is welcomed in the iron trade. The high price of coke was creating a grave problem for the ironmasters, who found costs of production advancing without any chance of passing it on to the consumer as in the days of the boom. Quotations are firm, No. 1 and siliceous iron being 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; No. 4 forge, 85s.; and mottled and white, 82s. 6d.

Hematite Pig Iron.

The situation in the hematite pig iron trade is also improving. Makers have been filling their order books lately, and it is difficult now to get iron for delivery before the end of the month. Prices, too, are very firm, and whilst it is possible to buy mixed numbers at 93s., some makers ask 93s. 6d., and in many cases a 1s. premium is asked for No. 1 quality.

Iron-making Materials.

Foreign ore prices are still depressed, and it is possible that a firm offer of 22s. per ton for best Rubio ore c.i.f. Tees would not be refused. A few cargoes of Mediterranean ores are changing hands, but the expected expansion in business has not yet developed. The coke market is easier, but the price of coke is still high. There have been some sales at specially low rates to favoured clients, but the market quotation for good medium furnace coke is not less than 30s. per ton delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade shows increasing signs of activity. Buyers are showing more interest in the position, and realising that no further price concessions can be looked for, are beginning to show less hesitancy about placing orders. The few shipbuilding orders recently placed have not materially helped the mills usually engaged in the production of shipbuilding material, but there are a few more rail orders about, and a better demand for constructional material. Foreign competition in semi-steel is very severe. Aided by the depreciated exchange, the French and Belgians have been selling billets round £6 per ton, and many thousands of tons have been sold to consumers in the North of England for rolling into sheets, light bars, wire, &c. There is, however, a good deal of delay in delivery, and it is understood that no more orders can be booked for delivery of this foreign steel before January. Local billets (soft) are 5s. cheaper at £7 5s., but otherwise the prices are unchanged, and tend, in fact, to advance.

The Coal Trade.

A much quieter tone characterises the Northern coal trade, and a period of marking time appears to have arrived. The position of the collieries is fairly satisfactory, most of them having disposed of their output for several months ahead, but for all that the situation is not nearly so clear and assured as it was a little more than a fortnight ago. It is felt and feared that the further sensational slump in the foreign exchanges is bound to react adversely and to a considerable extent on the possibilities of the foreigner being able to take out the quantities already purchased, so that should any considerable amount of cancellations take place, resulting in the release of supplies on the open market, values will be weakened and prices may recede. At the moment, however, the position of the market remains steady, and though there is no extensive buying going forward for abroad, the home trade is expected to improve, and in that way serve to steady the position until the present anxious financial situation is relieved. Best and second Northumberland screened steams are firm direct from the collieries, and steady through merchants. Small steams are plentifully offered, and are weak at lower prices. Special Durham gas coal, together with the best qualities, continues to find ready outlets at full figures, while in the main second-class gas and good brands of coking are moderately steady, though some of the commoner brands are easier. Bunker coals remain firm, especially for the best sorts. Foundry coke of every kind is easing down, though gas coke remains nominally steady at recent figures.

Iron and Steel Imports.

Interesting returns have been issued by the Tees Conservancy Commissioners of the imports of iron and steel to the Tees from Holland, France, Belgium, Norway, Sweden, and Germany and coastwise for the twelve months ending October, 1922, as compared with the previous twelve months and the corresponding partial pre-war period of 1913–14. They show the unloadings of pig iron for the past year to have been 34,631 tons as against 73,292 tons for the previous year, and 1427 tons for the corresponding period of 1913–14. Plates, bars, angles, sheets, joists, &c., imported during the past year amounted to 6816 tons, as against 20,972 tons for the previous twelve months and 19,482 tons for the corresponding period of 1913–14. Crude sheets, bars, billets, blooms, slabs, &c., arriving in the Tees during the past year are returned at 54,614 tons, as against 35,268 tons for the previous twelve months and 33,265 tons in the 1913–14 period.

SCOTLAND.

(From our own Correspondent.)

Slow Improvement.

MARKETS generally continue quiet. Business, on the whole, is fitful, with few signs of increase on home account. More shipbuilding orders have been placed on the Clyde and a more hopeful feeling is again apparent, but the effect on kindred industries has been of little moment so far. The growth in export inquiries is maintained, but it is still doubtful if much of the business secured is of a remunerative character. Wages are lower

but raw materials continue on a fairly high level. Competition from continental sources is again very keen, and home producers are at a distinct disadvantage when the price alone is the deciding factor.

Pig Iron.

The situation in the pig iron trade has not changed during the week. The production is still mainly absorbed by deliveries against export contracts. These orders are drawing to a close, and the state of the demand at present indicates dull times ahead. Foundry qualities are slow and prices have weakened a little. Unless the home trade improves before the present contracts cease accumulation of stocks is almost certain.

Steel and Iron.

Business in the steel trade is mainly of a dull description. Inquiries have certainly broadened out in various directions, and here and there employment is better; but in no sense can business be said to have increased in ratio to the inquiries. In some cases engineering and constructional works have been booking more orders, and shipyards here have received a few contracts, but until something more approaching a general improvement occurs industry on the whole must remain comparatively dull. Steel works are quiet. Orders for plates and sectional material are difficult to secure. A considerable portion of the business on offer is not of a paying nature, and while a certain quantity may be accepted in order to keep the works going, much has to be refused. In few instances are steel makers well employed. A small number of export orders have come to hand, but home demands are extremely poor. The heavier gauges are neglected. The inquiry for scrap has fallen off to some extent, but supplies being scarce, prices rule firm. Bar ironmakers have had more orders for material for immediate delivery, but have nothing in the way of substantial contracts to report. Re-rolled steel bars are similarly placed. Apart from the recent drop in foundry pig iron, prices are nominally unchanged, but in the majority of cases quotations can be adjusted if sufficient inducement is offered.

Coal.

A reduced German demand is held to be responsible for the quieter conditions in the coal market during the past few days. The collieries in all districts, however, have plenty of orders on hand and prices are firm. In the West of Scotland best ells and splints are especially firm for export. Strong quotations are named for small parcels for immediate delivery and high figures are also quoted for future dispatch. Collieries in the Lothians and Fifeshire have no difficulty in finding an outlet for their production, and a loading turn of several days is reported from the principal ports. Round coals are all firm. Treble nuts still supply the strong feature in washed materials. Doubles have improved a trifle, but singles, pearls, and dross show continued weakness. Aggregate shipments amounted to 317,990 tons, against 341,445 in the preceding week and 326,148 tons in the same week in 1913. In the home market fuel for household purposes is in good demand even at higher prices. The price averages about 2s. 1d. to 2s. 2d. per cwt. for good qualities. The cheap brands are not in favour. The demand for coal for gas and electricity works is increasing as the season advances, but ordinary industrial requirements are very easily satisfied.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

Coal exports from this district last week were again very satisfactory, the total shipped for foreign destinations being not far short of 638,000 tons. The record for the past fortnight has been quite unusual, inasmuch as the volume has exceeded the pre-war average by about 70,000 tons, this being at the rate of approximately three and a-half million tons per annum. There is no reason why this level should not be maintained for the remainder of this month, if not for the rest of this year, as the collieries are very well stemmed, and judging from recent chartering operations, there is a good deal of tonnage due to come along, apart from which fact the docks are well supplied with steamers. The trouble of many undertakings is that they cannot secure prompt loading berths for the tonnage that is already to hand, and this, of course, handicaps them in finding a regular outlet for their coals, and causes a certain amount of weakness in the market for absolutely spot shipment. Otherwise the conditions are very firm, as most of the salesmen of the collieries producing the better class of coals have practically full order books for the next few weeks. The outlook is very encouraging, more especially as the threatened trouble on the non-unionist question has completely disappeared, as the miners have decided to withdraw the notices that were served on October 23rd. It is quite true that a certain amount of difference exists still regarding the application of the award of Lord Buxton respecting the subsistence allowance, but at the moment there is no reason to apprehend any serious trouble on this head. The inquiry for coals is general, despite the adverse foreign exchanges, and the only fear is that the financial uncertainty prevailing may from now on exert an unfavourable influence upon future operations. Coal prices are certainly high enough, and it is preferable that values should go no higher, as otherwise the tendency will be for foreign buyers to hold off or look elsewhere for their fuel requirements.

Purchasing Ahead.

By this time it has usually been the case that quite a good deal of business has been carried through for supplies of coal for delivery over the following year, but so far the amount can be described as scarcely more than negligible. Business has been discussed, but for the most part buyers consider that the prices demanded are too high. Colliery salesmen are indicating 27s. for best Admiralty large, 26s. for second Admiralty large, and 24s. 6d. to 25s. for Monmouthshire large. These figures are undoubtedly fairly stiff for supplies over a whole year or even for the first six months of 1923, but collieries are bound to ask for higher prices than they have in previous years contracted at, as their working costs are greater and they have to face the prospect of having to pay the miners higher wages. Foreign consumers, however, for the most part decline to entertain the above-mentioned prices, and it is interesting to note that exporters on this side have been offering coals for Italy for next year at c.i.f. prices which show that exporters do not share the expectation of colliery salesmen that business can be done on the basis of their figures. An Egyptian private firm of coal consumers has recently been in the market for about 30,000 tons of steam coals for delivery at Alexandria by the end of March next, but although the c.i.f. prices quoted for this order discounted the colliery salesmen's figures for the coals, the order has been lost and the firm is taking oil fuel instead of coal. The Norwegian State Railways have also inquired for 15,000 tons of locomotive coals for delivery this month and next. Tenders had to be in by noon on Tuesday of this week, but it is questionable whether much, if any, of this business will come to South Wales, as the inquiry has also gone to the North, and in the past the bulk of this order has almost invariably been secured for North Country coals. Business is, however, reported to have been done in South Wales for the French State Railways, one firm of local exporters being credited with having obtained 100,000 tons of the order, the coals being for shipment over the first six months of next year. So far the prices at which the business has been taken have not been disclosed, but it is understood that the contract contains a clause that the purchasers have the right to cancel shipments in the event of the exchange exceeding 60f. to the pound sterling. The rate of exchange is now well over this figure, and from the conditions prevailing it may easily be that very little coal may be taken if the buyers exercise the power which they are reported to have.

Tin-plate Workers' Wages.

At a meeting of the South Wales Tin-plate Joint Industrial Council, held on Monday last at Swansea, consideration was given to the request from the men for a continuation of the 7½ per cent. concession granted to them some time ago and renewed for three months at the last meeting of the Council. It was pointed out that although the minimum price of tin-plates had been fixed at 19s. 3d. per basis box, this was somewhat counterbalanced by the advance in the price of block tin. The employers decided, however, to renew the 7½ per cent. bonus for a further three months, viz., until February 5th next.

Steel Works Restarting.

The satisfactory announcement is made that Guest, Keen and Nettlefold, Limited, restarted their works at Dowlais on Monday last. The hope is entertained that the result will be that several hundreds of men will shortly resume work. A portion of the works was closed down owing to the lack of orders, but it is understood that following on the efforts of the management, fresh orders have been obtained. The Blaenavon Company has also decided to restart its hot-blast furnace this week. This furnace was damped down some weeks ago.

Current Business.

The inquiry during the past week has been on a good scale, and the market all round is very steady except in some isolated instances for spot shipment. This is due to the fact that some of the collieries which may have quite a good supply of tonnage in dock are not fortunate in having their ships in berth. There is considerable pressure for loading berths, and the amount of tonnage that is shortly due to come along is fairly substantial. Bad weather has delayed the arrival of many steamers. On the whole, quotations have not undergone much change as compared with a week ago, but collieries have not much coal to offer for shipment this month and the early part of next.

Swansea Metal Market.

The tone prevailing in the tin-plate section is good. The fixing of a minimum of 19s. 3d. per basis box has rather put life into business, but the advisability of advancing the minimum to 19s. 9d. is not favoured in some directions, as the opinion is held that this might check rather than improve operations.

Pipe Line Contracts.

It is reported that Jordans, Ltd., and Thomas Spittle, Ltd., foundry proprietors of Newport, have decided to accept the offer of the Newport Corporation respecting the Talybont pipe line contract. Owing to the conditions imposed by the Corporation, the firms in question withdrew their tenders, but in view of so much unemployment in the town, it was felt that the contracts, amounting to £101,960 11s. 2d., should go to local firms. Jordans, Limited, and Thomas Spittle, Limited, were therefore asked by the Corporation whether they would agree to accept the contracts on the same terms as provisionally let to Messrs. Cochrane and Company, Limited, of Middlesbrough, and it is understood they have agreed to do so.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Richard Johnson, Clapham and Morris, Limited, Manchester, inform us that, in order to cope with their increasing business, they have taken additional warehouse accommodation in Trafford Park. This is, however, only a temporary expedient, and at a later date a special building will be erected on a site of 9000 square yards, which the company has also acquired in Trafford Park.

Dr. J. F. Crowley, having recently severed his connection with the English Electric Company, was on Tuesday last presented with a mahogany clock as a mark of esteem. The presentation was made by Mr. P. J. Pybus, managing director, on behalf of his friends and colleagues.

L. Mitchell and Co., Limited, ask us to state that on and after to-morrow, November 11th inst., their offices will be moved from 54, Gracechurch-street, E.C. 3, to 17, Philpot-lane, London, E.C. 3. Their telegraphic address will remain the same, namely, "Kingtruss, Bilgate, London," and their new telephone number will be Minories 1811.

LAUNCHES AND TRIAL TRIPS.

Paris Maru; built by Cammell Laird and Co., Limited, to the order of the Osaka Shosen Kaisha; dimensions, 450ft. by 56ft. 6in. by 43ft. 3in.; to carry 1812 tons. Engines, Parsons' compound turbines, pressure 200 lb.; constructed by the builders; trial trip, October 2nd.

Amsterdam; steel screw tanker; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of the American Petroleum Company, Rotterdam; dimensions, 440ft. by 57ft. 6in.; to carry 10,450 tons. Engines, triple-expansion; constructed by the builders; trial trip, October 6th, 1922.

Volendam; Holland-America liner; built by Harland and Wolff, Limited; dimensions, 575ft. by 67ft. by 44ft. 9in.; to carry 15,400 gross tonnage. Engines, twin-screw, pressure 215 lb.; trial trip, October 12th, 1922.

City of Evansville; steamer; built by William Gray and Co., Limited, to the order of the Ellerman Hall Line, Limited; dimensions, 451ft. by 57ft. 3in. by 32ft. 10in. Engines, triple-expansion, 24½in., 42½in., 74in. by 51in. stroke, pressure 225 lb.; constructed by the builders; trial trip, October 13th, 1922.

British Scout; screw steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the British Tanker Company, Limited; dimensions, 245ft. by 37ft. beam; to carry 2000 tons. Engines, triple-expansion; constructed by the builders; trial trip, October 14th, 1922.

The London Press Club.—The London Press Club celebrated its fortieth birthday by a dinner at the Edward VII. Rooms, on Saturday last. The chief guests were to have been the Prime Minister and Lord Birkenhead, but owing to political affairs they could not attend. Lord Riddell and Sir Johnson Forbes Robertson were the principal speakers. There was an admirable musical entertainment. It was satisfactory to hear that after many vicissitudes the London Press Club is now soundly established and its advantages greatly appreciated by "Fleet Street."

A Petrol Pump.—We have received from Cole, Marchent and Morley, Limited, of Bradford, some particulars of a little pump, which, it is said, has proved to be very satisfactory for such purposes as pumping oil and petrol on aeroplanes or motor cars. It comprises a plunger set transversely across the end of a short crank shaft. The crank has a spherical end, which engages with a recess in the centre of the length of the plunger. The result is that the plunger is given a reciprocating motion, and at the same time is oscillated slightly about its own axis. This oscillation is taken advantage of for opening and closing the inlet and outlet ports, which are drilled near the ends of the plunger. The pump is either single or double-acting, and the moving parts are made as light as possible, so that it may be run at speeds as high as 2000 revolutions per minute. It is made in several sizes ranging from ¼in. to 2in. bore, with capacities up to 340 gallons per hour.

Finsbury Technical College Old Students' Association.—The Finsbury Technical College Old Students' Association held its eleventh annual dinner on Saturday, November 4th, at the Engineers' Club, and seventy-three members and their guests participated in a very enjoyable evening. The toast of "The College" was proposed by Mr. A. Chaston Chapman, F.R.S., who spoke in glowing terms of the eminent men they had turned out, and hoped they would continue to do so for many years. Dr. W. H. Eccles, F.R.S., in his reply, referred to the loss the College had sustained in losing the Vice-chairman of the College Delegacy, Dr. M. O. Forster, F.R.S., a past student of the College, who had been appointed to the directorship of the Institute of Science at Bangalore, and also in Mr. Catterson-Smith, who had been selected to fill the Chair of Electrical Engineering at the same Institute. He also referred to the disadvantage they were working under inasmuch as many people were under the impression the College had closed its doors, and asked all present to try and dispel this rumour as soon as possible. Mr. F. Gill, in proposing the toast of "The Association," gave some interesting reminiscences of some of his early visits to Finsbury, and wished the Association every success in its work. Mr. W. G. Head, the President of the O.S.A., in his reply, stated that in spite of the activities of the Membership Sub-committee their numbers were not what they ought to be, and urged all present to try and persuade more old students to join. Mr. W. M. Mordey, the President-elect of the O.S.A., in proposing the toast of "The Guests," said that the Association felt highly honoured that they numbered among their guests that evening no less than three Presidents of Institutions—the "Chemicals," "Electricals" and "Mechanicals." Dr. Hele-Shaw, F.R.S., in his reply on behalf of the other guests and himself, stated he was proud to be able to say that he was one of the late Dr. Thompson's first pupils at Bristol University.

The Institute of Marine Engineers.—The annual dinner of the Institute of Marine Engineers, the twenty-seventh of its kind, which was held last Friday at the Hotel Cecil, was an imposing function. The tables were laid in the Grand Hall, but so many were the guests and members—it is said that they numbered 700 odd—that the company overflowed into the adjoining Oak Room. The President of the Institute, Engineer-Vice-Admiral Sir George G. Goodwin, took the chair, and in spite of a sore throat, which must have caused him some pain in speaking, he made an interesting speech, in the course of which he said that he believed the cost of shipbuilding really could be reduced, so as to meet the demands of shipowners. He did not agree that steam machinery was doomed for marine service, and thought that it would be used for a long time yet on large vessels. For smaller ships, however, especially in the merchant service, there might be a future for Diesel engines with electric transmission gear. Sir John Dewrance proposed the toast of "The Naval, Military and Air Forces," which was responded to by Rear-Admiral F. L. Field, Lieut.-General Sir Travers E. Clarke, and Air Marshall Sir Hugh Trenchard, Bart. Mr. J. H. Scrutton, Chairman of Lloyd's Register, replied for "The Shipbuilding and Engineering Industries," remarking that it was not everywhere appreciated how much capitalists were doing in the way of holding the shipbuilding industry together by accepting unremunerative orders. In proposing "The Mercantile Marine," Sir H. Eustace Tennyson D'Eyncourt suggested that when the trade revival did come we would have to scrap a lot of obsolete tonnage and replace it with more modern vessels; while Sir Joseph Cook, High Commissioner for Australia, in replying, urged English shipbuilders to establish yards in Australia. Commander Sir Trevor Dawson asked the company to drink the health of the Chairman, remarking that during the period in which he had been associated with the engineering side of the Navy the power of warships had been increased by 100 per cent.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	22,6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 7 6	—
No. 1 Foundry	5 2 6	—
No. 3 Foundry	4 17 6	—
N.E. Coast—		
Hematite Mixed Nos.	4 13 0	4 13 0
No. 1	4 13 6	4 13 6
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 10 0	4 10 0
No. 4 Forge	4 5 0	4 5 0
Mottled	4 2 6	4 2 6
White	4 2 6	4 2 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 2 6	—
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 0 0	—
Foundry	4 2 0	—
Forge	4 0 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 10 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. Coast—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	10 10 0 to 10 15 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 12 6 to 9 15 0	
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates ¼in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ⅛in. to ¼in.	10 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 12 6

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 5 0	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 0 0	—
Light ,,	10 10 0 to 11 10 0	
Billets	9 0 0	—
Manchester—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic ,,	8 5 0	—
Soft ,,	7 5 0	—
Hoops	11 10 0	—
Soft Wire Rods	10 0 0	—
Midlands—		
Small Rolled Bars	8 15 0	—
Billets and Sheet-bars	6 17 6 to 7 0 0	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 10 0 to 17 0 0	
Angles	8 15 0	—
Joists	9 0 0 to 9 10 0	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/6 to 20/-
Block Tin (cash)	184 15 0
,, (three months)	185 5 0
Copper (cash)	63 10 0
,, (three months)	64 5 0
Spanish Lead (cash)	26 2 6
,, (three months)	25 2 6
Spelter (cash)	37 15 0
,, (three months)	35 17 6
Manchester—	
Copper, Best Selected Ingots	67 0 0
,, Electrolytic	71 10 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	27 15 0
,, Foreign	26 10 0

FERRO ALLOYS.

(All prices now nominal)

Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
	Per Ton.	Per Unit
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22	10/6
,, 6 p.c. to 8 p.c. ,,	£21 10 0	8/6
,, 8 p.c. to 10 p.c. ,,	£21 10 0	8/-
,, Specially Refined ,,		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£65 0 0	22/6
,, ,, 0·75 p.c. carbon	£73 0 0	25/-
,, carbon free	1/7 per lb.	
Metallic Chromium	4/9 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/6 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
,, ,, Ell	25/6
,, ,, Splint	26/- to 28/-
,, ,, Trebles	23/6
,, ,, Doubles	22/-
,, ,, Singles	18/3
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	26/-
,, ,, Trebles	28/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	22/- to 26/-
Screened Navigation	23/-
Trebles	24/6
Doubles	22/-
Singles	19/-
Lothians—	
(f.o.b. Leith)—Best Steam	24/6
Secondary Steam	23/6
Trebles	24/6
Doubles	22/3
Singles	19/6

ENGLAND.

	Export.
(8) N.W. Coast—	
Steams	29/6
Household	46/8 to 57/6
Coke	34/-
Northumberland—	
Best Steams	26/- to 27/-
Second Steams	24/- to 24/6
Steam Smalls	15/- to 16/6
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 24/6
Second	22/- to 22/6
Household	25/- to 28/-
Foundry Coke	37/- to 40/-

Sheffield—	Inland.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 25/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	19/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	8/6 to 10/6 —
Nutty ,,	7/6 to 8/6 —
Smalls	3/- to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-

(9) SOUTH WALES.

Cardiff— Steam Coals:	
Best Smokeless Large	28/- to 28/6
Second ,, ,,	27/- to 27/6
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/6 to 28/-
Best Black Vein Large	25/6 to 26/-
Western Valley ,,	25/6 to 26/-
Best Eastern Valley Large	24/6 to 25/-
Ordinary ,, ,,	22/6 to 24/6
Best Steam Smalls	16/- to 17/-
Ordinary ,,	12/- to 14/-
Washed Nuts	25/- to 30/-
No. 3 Rhondda Large	28/- to 29/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	21/6 to 22/6
,, ,, Through	18/6 to 21/-
,, ,, Smalls	12/- to 14/-
Coke (export)	37/6 to 42/6
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	31/6 to 32/6
Swansea— Anthracite Coals:	
Best Big Vein Large	55/- to 57/6
Seconds	45/- to 50/-
Red Vein	40/- to 45/-
Machine-made Cobbles	70/- to 72/6
Nuts	72/6 to 75/-
Beans	42/6 to 45/-
Peas	21/6 to 23/-
Breaker Duff	9/- to 9/6
Rubbly Culm	14/6 to 15/-
Steam Coals:	
Large	25/- to 27/6
Seconds	23/- to 25/-
Smalls	12/- to 14/-
Cargo Through	18/- to 22/6

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.
(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Trade Improvement.

While it cannot be said that there is a general improvement in the engineering trades, the situation is nevertheless much better in many departments, and the outlook appears more encouraging. The only disturbing factors are the financial situation, which is delaying the execution of important works, and the difficulty of procuring sufficient supplies of coke, this being a serious problem for blast-furnace owners who find the future anything but reassuring unless the experiments being carried out in the Saar district confirm what has been repeatedly said that it is possible to make up for the deficit of cokes from the Ruhr. So far as the engineering trades are concerned, some firms have orders in hand to last them for several months. The boilermakers are well employed, and makers of steam turbines are especially busy. All those concerned in the repairing of railway rolling stock have an abundance of work. On the other hand, machine tool firms are doing very little, the depression in that branch being so general that some shops have been closed. So long as the industrial activity is limited to reconstruction work and to the carrying out of railway and other public undertakings, it must be more or less erratic, and can only affect certain trades, and as the impression is gaining ground that a general recovery is only possible by means of an active foreign business, there is a very strong movement in favour of facilitating an interchange of goods with foreign countries. Unfortunately, these economic questions are so closely bound up with the budget difficulties and the financial disturbance caused by the further depreciation of the franc that any reform in the trade policy is being regarded by the Government with extreme caution.

Contracts from Poland.

Under the commercial treaty entered into with Poland a little while ago, special advantages were offered to French manufacturers in the way of supplying that country with what it requires for the carrying out of railway construction and other works. A financial group was formed, including all the leading engineering firms, with a view of "reconstructing" Poland, and it is understood that contracts will soon be distributed amongst ten firms belonging to the group for material, plant and machinery to the value of no less than 900 million francs.

Railway Electrification.

The first electric locomotive to be put into service on the southern lines made its official trial last week between Pau and Tarbes. This is one of fifty locomotives being built at Tarbes for the Midi line, and is a standard type to be adopted for the Midi, Orleans and P.L.M. railways in accordance with the electrification scheme which is to be carried out completely within a period of fifteen years at an estimated cost of 5500 million francs. The object of the scheme was primarily to reduce the running costs of the railways by utilising the hydraulic energy in the Pyrenees, whereby it is expected to economise one and a-half million tons of coal a year. It will also permit of railways being extended into the mountainous districts. The line between Pau and Tarbes is supplied from the Soulon station, where alternating current at 60,000 volts is transformed to direct current at 1500 volts. The locomotive weighs 72 tons, and has two bogies with a motor on each of the four axles. Its speed is about 55 miles an hour. As soon as a sufficient number of locomotives are delivered the service between Pau and Tarbes will be completely electrified, and at the beginning of next March the electrification will extend from Tarbes to Montréjeau, while later in the year the whole of the line will be running electrically between Dax and Toulouse.

A Railway in Difficulties.

The Chemins de Fer du Sud-Est is a small company, the system of which is limited to the departments of the Ariège and the Haute-Garonne. As it is by no means a remunerative undertaking the railway has only been kept running with the occasional assistance of the State, but now that such aid has been withdrawn the Compagnie du Sud Est has found its difficulties accumulating to such an extent that it has been obliged to advise the Government of the total cessation of the service on October 31st. The notice given was so short that nothing could be done in time to ensure the continuance of the service, with the result that the populations of two departments suddenly found themselves completely shut off from the rest of the world. The Government then took possession of the railway, and the service has been resumed under the management of State engineers, and will so remain until such time as some decision can be come to regarding the future of the system. It is possible that it will be incorporated into the Midi railways.

Railway Accidents.

An extraordinary fatality, resulting in the loss of twenty lives, occurred last week at the Chatelaudren Station, near Guingamp, on the Paris-Brest line. During a violent snowstorm a goods train was, through some misunderstanding, sent down on the main line just before an express was due. The distance signal was put against the express, which, however, approached the station at a speed of 60 miles an hour and dashed into the goods train. It is fairly certain that the distance signal did not work through being blocked by the snow, and the responsibility appears to lie with the man who sent on the goods train, as the regulations forbid any manœuvring of this kind during snowstorms. On the following day another curious accident occurred in Paris near the Batignolles tunnel, when the wheels of a first-class coach spread, and the vehicle, after running on the ballast, turned over. The gas reservoir burst and the coach was immediately in flames, though fortunately there do not appear to have been any passengers. The dangers of gas lighting are constantly being brought home by accidents of this kind, and although the beginning of next year has been fixed for the equipment of trains for electric lighting, it is to be feared that it will be a long while yet before gas is entirely eliminated from railway coaches.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

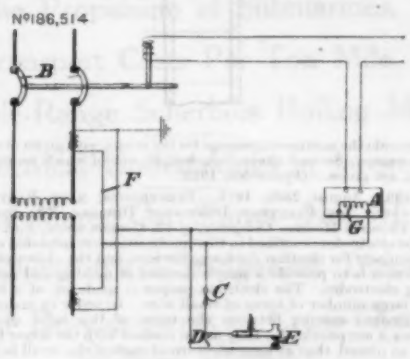
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

186,514. September 8th, 1921.—Improvements in or relating to Protective Devices for Electric Transformers, Thomas Wylie Ross, of 38, Longford-avenue, Stretford, Manchester, and the Metropolitan-Vickers Electrical Company, of 4, Central-buildings, Westminster.

According to this invention means are provided which only bring the kick fuses of electric protective systems into operation at times when they are required. The kick fuse for preventing the relay A from being operated by the surging currents which occur in the transformer upon the closure of the circuit breaker B is indicated at C. The kick fuse is included in a circuit D, which is provided with a switch E, by means of which the kick fuse can

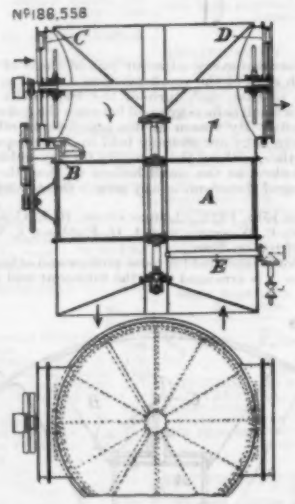


be connected or disconnected as desired. The switch is adapted to be closed by hand immediately before the circuit breaker B is closed, and when the circulating currents, if any, due to surging have ceased to flow in the circuit F the switch E may be opened. During the time that the switch is closed the coil G of the relay will be short-circuited by the fuse C, so that the circuit breaker B will not be tripped by the circulating current which may occur when the circuit breaker is closed unless the circulating current attains such a value, by reason of a fault or otherwise, as will blow the kick fuse C. If this occurs the relay will immediately operate and open the circuit breaker B.—*October 5th*, 1922.

LIGHTING AND HEATING.

186,558. February 21st, 1922.—Regenerative Air Heaters, Aktiebolaget Ljungströms Angturbin, Arsenalsgatan 2, Stockholm.

In this heater the regenerator A is rotated by the friction gear B. The main casing is divided by a vertical partition so as to provide a passage on the left for the air to be heated and another on the right for the flue gases. Two fans C and D at the top of

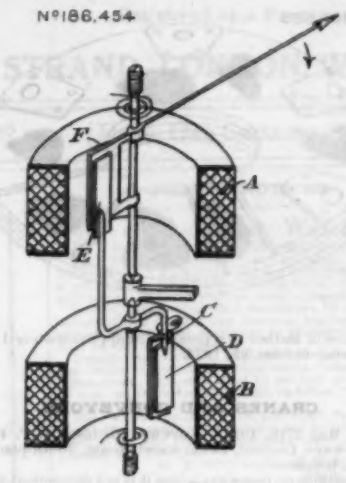


the casing draw the air and flue gases through the heater in the directions shown by the arrows. A perforated steam pipe is provided at E for blowing soot and dust out of the regenerator.—*October 5th*, 1922.

MEASURING AND TESTING INSTRUMENTS.

186,454. October 5th, 1922.—Improvements in Electrical Measuring Instruments, John Westmoreland Record, of Hazeldene, Winton-road, Bowdon, Chester.

The object of this invention is to increase the angular deflection of the pointers of electrical instruments. Two coils A B are disposed in different horizontal planes one above the other, and each coil is provided with independent approximately coaxial spindles. The lower coil contains a fixed iron piece C and a moving iron piece D attached to the lower spindle and free to rotate. The upper coil also contains two iron pieces E and F, the moving element F being fixed to the upper spindle, to which also is attached the pointer, whilst the other, a "floating" iron piece E, carried by an arm or its equivalent, is extended from the lower spindle and arranged to follow in the track of the upper moving iron. The current to be measured traverses both coils. The lower moving iron D would, if free from all control, deflect approximately 180 deg. in respect of the fixed iron C, and the upper moving iron F and pointer would also, if free from control, deflect approximately 180 deg. in respect of the floating iron E; but as the latter has travelled through 180 deg. in the track of

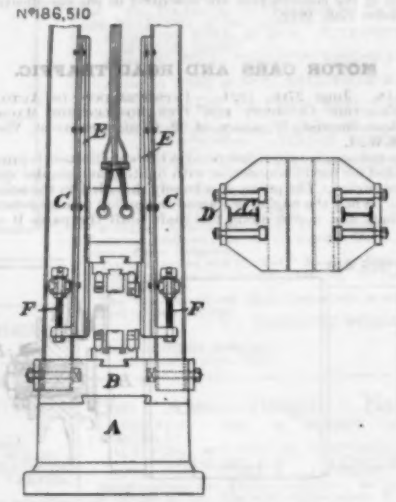


the moving iron D, the index pointer will have travelled approximately 360 deg. in respect of the fixed iron C, which was the starting point for them both.—*October 5th*, 1922.

MACHINE TOOLS AND SHOP APPLIANCES.

186,510. September 2nd, 1921.—Drop Hammers, B. Brett, Brett's Patent Lifter Company, Limited, Foleshill Works, Coventry.

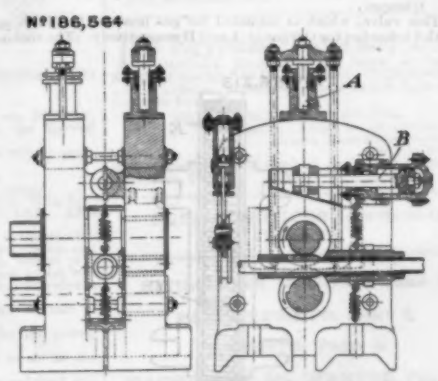
This invention provides for the bursting stresses set up between the guides of drop hammers when the dies are not symmetrical. The anvil comprises an ordinary cast iron base A and an upper part B of cast steel. The standards C C are tied into this steel



casting by means of the bolts and cover plates D. The standards are set at a slight angle, leaning towards one another, and the guide strips E E are correspondingly tapered. Adjustment of the guides is effected by the screws F F.—*October 5th*, 1922.

186,564. June 22nd, 1921.—Tube Rolling Mills, U. Marchi, Via Celesia 7A, Rivarolo Ligure, Italy.

This adjusting gear is intended primarily for tube rolling mills of the Pilger type. The bearings of the upper roll are supported



by hydraulic rams A, which are kept constantly under pressure. A second double-acting ram B is used to move the wedges arranged above the bearings of the top roll, and thus adjust the height of the roll.—*September 22nd*, 1922.

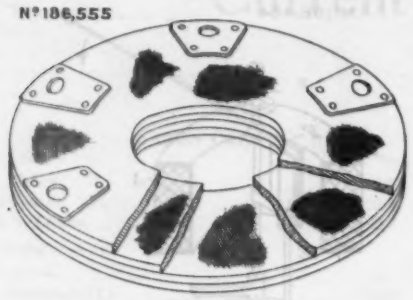
TRANSMISSION OF POWER.

186,555. February 7th, 1922.—Flexible Couplings, H. P. Tullis and John Tullis and Son, Limited, St. Ann's Works, 86, John-street, Bridgeton, Glasgow.

The inventors propose to make the discs for flexible couplings by submitting a chrome tanned butt of leather to a longitudinal stress or stretch of approximately 120 lb. pull per inch, and a transverse strain or stretch of approximately 80 lb. to 90 lb. pull per inch; then securing pieces of butts together by dissolved

celluloid or its equivalent, in such a manner that the grain due to the longitudinal stress in the separate pieces is arranged at relatively different angles; and afterwards subjecting the super-

Nº186,555



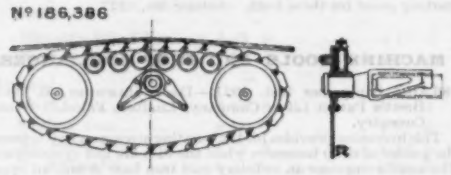
posed pieces of leather to a pressure of approximately 1 ton per square inch.—*October 5th*, 1922.

CRANES AND CONVEYORS.

186,386. May 27th, 1921.—Ropeway Guides, J. P. Roe and Ropeways, Limited, Eldon-street House, South-place, Finsbury, London.

For situations on ropeways where it is not convenient to install a large sheave for supporting the rope, but where, otherwise, a large one is desirable, the inventor proposes to use a device very

Nº186,386



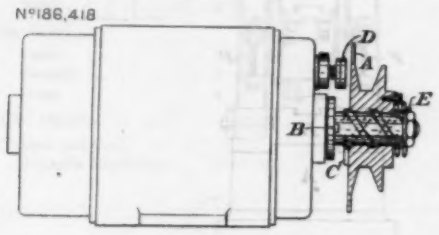
similar to the caterpillar track used on some vehicles. The details of the construction are described in the specification.—*September 27th*, 1922.

MOTOR CARS AND ROAD TRAFFIC.

186,418. June 27th, 1921.—Improvements in Automatic Electric Cut-outs for Dynamo-electric Machines, Jean Baptiste Bignamy, of 92, Gloucester-street, Victoria, S.W. 1.

The automatic switch described in this specification is primarily intended for use in connection with lighting and similar systems on motor cars. The pulley A is loosely threaded on the armature shaft. When the engine is started the pulley rotates relative to the shaft and moves along the shaft until the parts B and C

Nº186,418



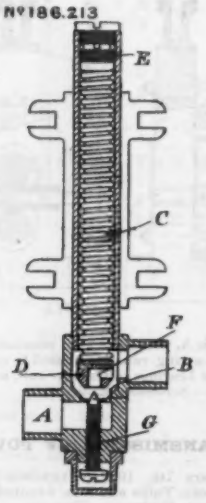
engage. At the same time the pulley presses against the cap D and closes the dynamo circuit. When the engine stops the pulley moves along the shaft in the opposite direction under the action of a spring E and the circuit is broken.—*September 27th*, 1922.

MISCELLANEOUS.

186,213. July 30th, 1921.—A Thermostatic Valve, A. D Horne, The Horne Engineering Company, Pitt-street Glasgow.

This valve, which is intended for gas heaters, has inlet and outlet branches for the gas at A and B respectively. The thermo-

Nº186,213

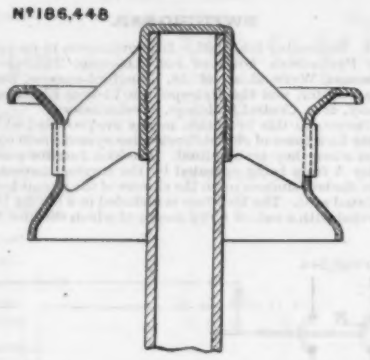


expansion element C consists of a spirally corrugated tube containing a liquid such as olive or castor oil, having a higher coefficient of expansion than that of the tube and is closed at opposite ends by a valve member D and an externally screwed plug E. The liquid does not completely fill the tube, the remaining space being exhausted of air. The valve member D is pierced by a by-pass channel F, and screwed into the base of the chamber is a screw G the tip of which is adapted to seat in the base of the by-pass. The valve is set for any desired temperature by means of the screw E, while the by-pass is used to keep the flame alight.—*September 28th*, 1922.

186,448. July 7th, 1921.—Double-beat Valves, Lentz-Lokomotiv-Umbau-Aktiengesellschaft, Schenkenstrasse 8–10, Vienna, Austria; and H. Lentz, Hauptstrasse 46, Mauer, near Vienna.

The inventors make double-beat valves out of sheet metal pressings, instead of castings, in order to reduce their weight and

Nº186,448

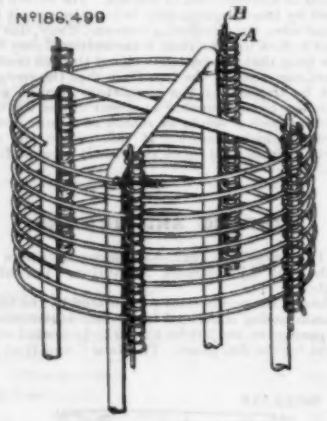


to provide the maximum passage for the steam with given overall dimensions. Several alternative designs, one of which we reproduce, are given.—*October 5th*, 1922.

186,499. August 25th, 1921.—Electrodes, more Particularly for Electron Discharge Devices, *The British Thomson-Houston Company, of 83, Cannon-street, E.C. 4.*

The electrodes described in this specification are intended more particularly for electron discharge devices, and the object of the invention is to provide a simple method of making and assembling electrodes. The electrode proper is made up of a helix of a large number of turns of small wire. In order to maintain the desired spacing between the turns of this helix smaller helices A are provided. They are in contact with the larger helix and so placed that at least one turn of each of the small helices

Nº186,499

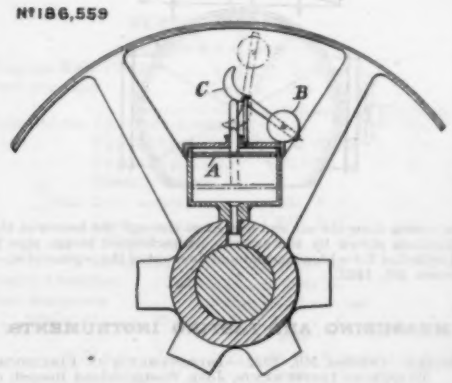


is interposed between every adjacent pair of turns of the large helix. Through each of the smaller helices a rod B is threaded longitudinally, so that each turn of the large helix where it passes through a small helix is gripped between the rod and a turn of the small helix. By reason of this interlocking relation the turns of the large helix are securely held in desired spaced relation to one another, without the necessity for any welded points, and are also locked to the small helices so that they cannot become disengaged therefrom in any way.—*October 5th*, 1922.

186,559. March 15th, 1922.—Lubricators, R. E. Goldsbrough, C. Crute, C. P. Wayman, and A. G. Robbins, 4, Weardale-place, Stockton-on-Tees.

This lubricator is intended for loose pulleys and other rotating parts. A piston A is arranged over the lubricant and is pressed

Nº186,559



in by the centrifugal action of the weight B. The end of the lever C is so shaped as to counteract the increase in the centrifugal force as the weight B moves outwards.—*October 5th*, 1922.

Royal Institution.—A general meeting of the members of the Royal Institution was held on Monday afternoon, the 6th instant, Sir James Crichton-Browne, treasurer, in the chair. Viscount Falmouth, Dr. Michael Grabham and Mr. N. Miesegaes were elected members. The chairman reported the deaths of Colonel E. H. Grove-Hills, secretary and vice-president; and of Lord Scott Dickson, and resolutions of condolence were passed.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The Development of Ball and Roller Bearings," by Mr. A. W. Macaulay. 7.30 p.m.

The Institute of Metals: Sheffield Local Section.—Mappin Hall, St. George's-square, Sheffield. Chairman's address by Professor C. H. Desch. 7.30 p.m.

The Institution of Heating and Ventilating Engineers.—The Engineers' Club, Coventry-street, W. 1. Paper, "Instruments for Heating and Ventilating Engineers," by Mr. M. Kinoshita. 7 p.m.

Institution of Engineers and Shipbuilders in Scotland.—Grosvenor Restaurant, Glasgow. "James Watt" dinner. Reception 5.30 p.m., dinner 6 p.m.

SATURDAY, NOVEMBER 11TH.

Keighley Association of Engineers.—The Cycling Club, Cavendish-street, Keighley. Lecture, "Jigs and Fixtures and their Influence on Design," by Mr. T. Elliott. 6.30 p.m.

MONDAY, NOVEMBER 13TH.

The West Yorkshire Metallurgical Society.—Technical College, Huddersfield. "Aluminium," by Dr. Bramley. 7.30 p.m.

Bradford Engineering Society.—Technical College, Bradford. Lecture, "The Mechanical Handling of Goods," by Mr. C. Bentham. 7.30 p.m.

TUESDAY, NOVEMBER 14TH.

Institute of Marine Engineers.—85–88, The Minories, Tower-hill, E. 1. "The Evolution of the Nobel-Diesel Engine," by Mr. G. J. Steinheil. 6.30 p.m.

The Electro-Harmonic Society.—Caxton Hall, Westminster, S.W. 1. Concert (ladies' night). 8 p.m.

The Institution of Electrical Engineers: Scottish Centre.—207, Bath-street, Glasgow. Inaugural address by Mr. A. S. Hampton. 7.30 p.m.

The Junior Institution of Engineers: North-Eastern Section.—Armstrong College, Newcastle-upon-Tyne. Paper, "Notes on Shop Practice," by Mr. H. Lee. 7.15 p.m.

The Illuminating Engineering Society.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Opening meeting. 8 p.m.

Manchester Geological and Mining Society.—Queen's Chambers, 5, John Dalton-street, Manchester. Ordinary meeting. 3 p.m.

The Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 38, Elmbank-crescent, Glasgow. Paper, "Non-ferrous Alloys and their Uses in Marine Engineering," by Mr. J. W. Donaldson. 7.30 p.m.

Institution of Petroleum Technologists.—The Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper: "The Galician-Canadian Pole Tool Drilling System," by Mr. A. Millar. 5.30 p.m.

WEDNESDAY, NOVEMBER 15TH.

Liverpool Engineering Society.—Royal Institution, Colquitt-street, Liverpool. Paper, "Stability of a Pile Wharf," by Mr. S. H. Ellis. 8 p.m.

The Institute of Metals: North-East Coast Local Section.—Armstrong College, Newcastle-on-Tyne. Paper, "Moulding Sands," by Mr. O. Smalley. 7.30 p.m.

THURSDAY, NOVEMBER 16TH.

Northampton Engineering College Engineering Society.—St. John-street, Clerkenwell, E.C. 1. Paper, "Track Working in Connection with the Electrification of Railways," by Mr. D. A. Keith. 5.30 p.m.

The Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Demonstration of Cathode Ray Oscillations, by Mr. R. Webb. 5.15 p.m.

The Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Paper, "The Improvement of Power Factor," by the late Dr. G. Kapp, will be read by Professor Miles Walker. 6 p.m.

FRIDAY, NOVEMBER 17TH.

The Institute of Chemistry.—The dinner arranged for Friday, November 17th, is postponed on account of the General Election.

Faraday House Old Students' Association.—Hotel Cecil. Annual dinner. 6.30 for 7 p.m.

West Bromwich Engineering Society.—Technical School, West Bromwich. Paper, "The Ford Car: Its Design, Production and Service," by Mr. Sam Evans. 7.30 p.m.

The Junior Institution of Engineers.—39, Victoria-street, Westminster, S.W. 1. Forty-first annual general meeting. 7.30 p.m.

The Institution of Electrical Engineers: Scottish Centre, Students' Section.—Royal Technical College, Glasgow. Opening address by Mr. J. F. Nielson. 7.30 p.m.

FRIDAY, NOVEMBER 24TH.

The Institution of Production Engineers.—The Engineers' Club, Coventry-street, W. 1. Paper, "Standardisation," by Mr. G. Hey. 7.30 p.m.

WEDNESDAY, NOVEMBER 29TH.

The Newcomen Society.—The Iron and Steel Institute, 28, Victoria-street, S.W. 1. Annual general meeting. Paper, "Notes on the Early History of Steel Making in England," by Mr. Rhys Jenkins. 5 p.m.

Contracts.—The Corporation of Scarborough has placed an order with the Walker-Weston Company, Limited, for reinforcing the foundation at Huntriss-row, Scarborough, with the Walker-Weston interlocked double-layer reinforcement.